SCIENTIFIC AMERICAN SUPPLEMENT No. 309

Scientific American Supplement, Vol. XII., No. 309.
Scientific American, established 1845.

NEW YORK, DECEMBER 3, 1881.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THOMAS ALVA EDISON.

About the time the most famous son of Ohio, our late chief magistrate, was urging the refractory mule along the canal towpath, and hoping that he might ultimately rise to the high position of sailor on the lake, a younger Ohioan, not yet graduated from skirts (though long past the age when breeches are in order), was seriously considering the incubation of goose eggs. He was sure he could do it himself; and, late one night, after much parental searching, he was found in the woods serenely covering with his skirts a number of eggs which he had wrested from the parent fowl at the cost of many bruises from the strong wings of the old gander who objected to the robbery. The boy had laid by near at hand a quantity of food intended to last him until his self-imposed task was done. His father and mother did not approve of such nonsense, and the "nest" was broken up with some violence. Recalling the affair recently, the would-be incubator, who was no other than the subject of our sketch, confessed a lingering disappointment at the untoward issue of the experiment, and declared that if he were to attempt it now he would succeed, for he'd have more perseverance.

Though trivial, the story is characteristic of the man. A disposition to subject his opinions to the rigorous test of experiment, with fearless persistence and patience in providing the means for successfully prosecuting the experiment, regardless of the off-hand assertions of presumably wiser people that "it's all nonsense," has been a ruling trait all his life—a trait which has probably had more to do with his success as an inventor than any superior endowment of genius or brain power.

Mr. Edison was born February 11, 1847, at Milan, an obscure canal village in Erie county, Ohio. His parents were plain people, in very moderate circumstances. On his father's side the only notable family trait was a capacity for long living, indicating good physical stock. His mother had been a country school teacher, and her instructions took the place of schooling, of which young Edison's share was the smallest. The greater part of his boyhood was spent at Port Huron, whither his parents had removed. An inherent hunger for knowledge was early shown in an eager reading of whatever books he could lay hands on; they were not many, but fortunately they were for the most part sound and instructive.

At twelve he began to earn his living in the capacity of train boy on the section of the Grand Trunk Railway traversing Central Michigan. The peddling of apples, song books, and newspapers on the cars has not been considered a specially promising school for genius; but it did not suppress any latent germs of greatness that may have been in the boy, which is more, perhaps, than could be said of many more pretentious schools.

In the intervals of persecuting passengers, young Edison dabbled in chemistry, setting up his apparatus in a baggage car. This pursuit of real knowledge on the road was terminated abruptly by an accident which set fire to the car, when the apparatus was thrown out of the window and the unlucky investigator received a thrashing at the hands of the conductor. Off the road, knowledge was to be picked up at less risk in the railway shops and telegraph offices, and in the press rooms of the newspapers which he sold. The knowledge gathered in the last-named place was ultimately turned to profit when an opportunity offered for buying a lot of old type, with which the future inventor set up the first newspaper ever regularly printed on railway trains. It was called the *Grand Trunk Herald*, 12 x 17 inches in size, printed on one side, the editor-publisher's hands performing the office of printing press.

During the early part of the war of the rebellion, Edison conceived the idea of telegraphing ahead of the train intimations of the news in the coming papers, to insure a lively demand for his stock. This intercourse with telegraphers awakened in him a lively interest in the art, and led him to rude and boyish experiments with electricity. His initiation to the practical work of telegraphing was due to the master of one of the stations of the road, who taught him the art out of gratitude for pluckily snatching his child from before an advancing train. From this time, with a brief diversion to shoemaking, which he did not like, the investigation and practical application of electricity has been Mr. Edison's life work. He soon became an expert telegrapher, but was ill-adapted to be content with the routine work of the telegraph office. He was too prone to speculate upon possible improvements in the art, and to try experiments, by means of which he not only enlarged his knowledge of electricity, but also of the geography of the United States. His removals were frequent and sometimes peremptory. At last, after much knocking about, he fetched up in New York. He had already made some small successes in invention, and had attempted some large tasks, notably the development of a duplex system, in which, however, he had succeeded chiefly in convincing the "practical" managers who employed him that he was a visionary fellow that would never come to any good.

THOMAS ALVA EDISON.

Soon after arriving in New York, his attention was drawn to the indicator of the Gold and Stock Telegraph Company, which did not work well, and he invented an improved apparatus, which was adopted. This brought him money and a connection with the Western Union Company, which gave him opportunity to indulge his bent for investigation and invention.

For a number of years his work was done chiefly at Newark, N. J. In 1876 he started in a comparatively modest way, at Menlo Park, the establishment of which all the world has heard. Here were developed most of the multitudinous inventions which he has brought out in connection with telegraphing, telephoning, electric lighting, the transmission and conversion of electric energy, the phonograph, and so on. The bare list of his patents during the past ten years would go far to cover a page of this paper. Fortunately the readers of the Scientific American are already familiar with the more important results of Mr. Edison's marvelous fertility in inventive ideas, and scarcely less marvelous ability to work out by patient and protracted toil the useful materialization of his conceptions.

The excellent likeness herewith presented, engraved from a recent photograph, relieves us of any need of dwelling upon his personal appearance.

[FROM LA LUMIERE ELECTRIQUE.]

THE INTERNATIONAL EXHIBITION OF ELECTRICITY.

By TH. DU MONCEL.

EDISON'S INCANDESCENT ELECTRIC LAMPS.

IN a previous article we indicated in what case this system of electric lighting was specially applicable, and we saw that henceforth, thanks to important improvements recently introduced, it could be employed for the interior of houses where light of feeble intensity is used; we have seen that several castles in England were lighted in this way, and that a certain number of houses in the City of New York had subscribed for the light furnished by the Edison Electric Light Company. Since the successful introduction of these lamps, a great number of systems of the same kind have been brought out by different inventors, and without

FIG. 1.

speaking of such well-known ones as those of Edison, Swan, Maxim, Lane Fox, Sawyer, we know of about fifteen inventions bearing more or less upon the subject. It therefore seems to us an opportune moment to enter into circumstantial details about this method of lighting, which, up to this moment, has not excited any great interest in Europe for various reasons, which we have enumerated in different articles published in this journal at the commencement of the year 1880, of which the principal one was the relative considerable expenditure of motive force to produce a light of given intensity. It should be borne in mind that the luminous power of an incandescent body increases in a much greater ratio than the calorific intensity; therefore, by the very fact that incandescent lamps permit a greater division of the electric light, a loss is caused by the weakening of the radiating power resulting from the same. Nevertheless the satisfactory results recently obtained force us to pass these systems of electric lighting in series, and we will begin naturally enough with that of Mr. Edison, which has made

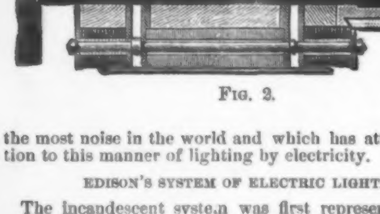


FIG. 2.

the most noise in the world and which has attracted attention to this manner of lighting by electricity.

EDISON'S SYSTEM OF ELECTRIC LIGHTING.

The incandescent system was first represented by lamps made from an incandescent platinum wire, and the interesting experiments made in 1879 by M. de Changy should be recollected; but the practical workings of this system were not satisfactory, principally because of the disaggregation and partial fusion of the wires, and in spite of the numerous improvements brought to bear on this system by Mr. Edison, who, by one of the most ingenious of processes, had rendered them more infusible and harder, still they had to be absolutely rejected, at least for ordinary lamps. Then it was suggested to employ carbon, which, if not allowed to burn, is infusible in the highest heat developed in the lamps, and different arrangements of apparatus were put together at various times by King, Lodyguine, Bouliguine, Swan, Sawyer, etc., some avoiding combustion by inclosing the

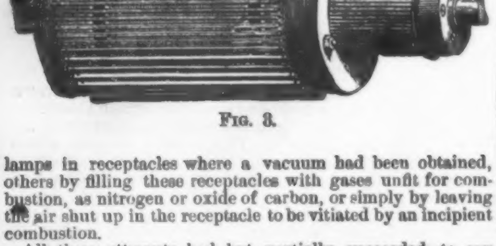


FIG. 3.

lamps in receptacles where a vacuum had been obtained, others by filling these receptacles with gases unfit for combustion, as nitrogen or oxide of carbon, or simply by leaving the air shut up in the receptacle to be vitiated by an incipient combustion.

All these attempts had but partially succeeded, to say nothing more, when, in 1879, the new incandescent carbon lamp of Mr. Edison was announced, and many savants, and myself in particular, doubted the exactness of the allegations which came to us from America. The carbonized paper horse-shoe appeared incapable of resisting mechanical shocks and of supporting incandescence for any length of time. At this epoch Mr. Swan himself said that up to that time he had not been able to obtain any very satisfactory results by an analogous disposition of the incandescent organ.

Mr. Edison, however, was not abashed, and, in spite of the lively opposition made to his lamps, in spite of the bitter polemic of which he was the object, he did not cease to perfect it for practical purposes, and has at last produced lamps, which we have seen at the Exposition and which can be admired by all the world for their perfect steadiness. These lamps, to the number of 160, light the two salons reserved for the discoveries of the ingenious American inventor, and we shall see still more important results upon the installation of the great machine which is expected from America.

As at present made, these lamps are sufficiently solid and can last a long time. The originally fragile carbon has become extremely elastic and hard, and of such attenuation that it can be well compared in size to a horse-hair. By a cleverly combined system of fastening the platinum, conducting wires are not exposed to be cut, and they are so sealed in the glass receiver that their change of volume under the action of heat does not endanger the perfection of the vacuum. By the way the carbons are treated when the vacuum is made in the globe, the bubbles of air inclosed in their pores, and which, in escaping, disaggregate the surface,

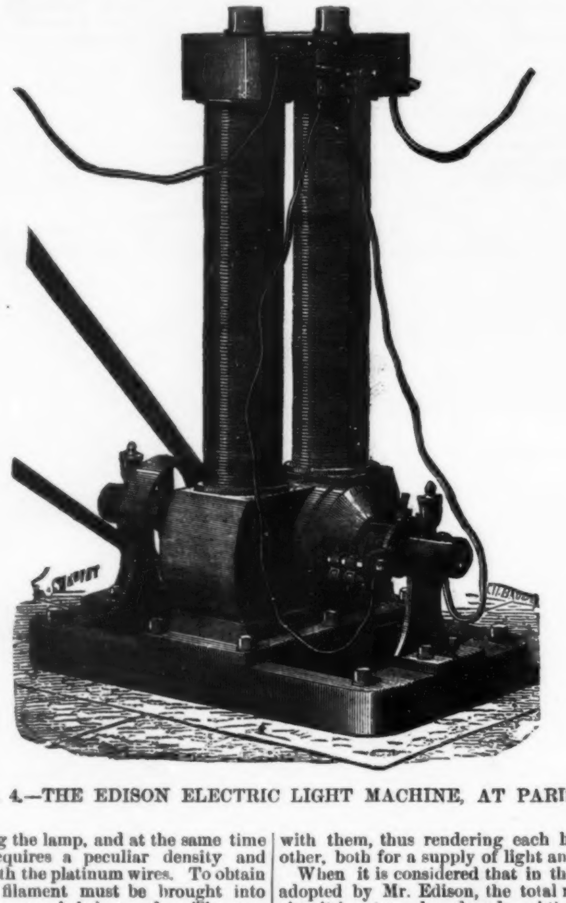


FIG. 4.—THE EDISON ELECTRIC LIGHT MACHINE, AT PARIS.

are evacuated before closing the lamp, and at the same time the filament of carbon acquires a peculiar density and hardness, as was the case with the platinum wires. To obtain this result the carbonized filament must be brought into incandescence while the vacuum is being made. The very nature of the substance of vegetable origin employed in its fabrication has been modified. Fibers of bamboo are now used instead of the paper originally employed. These are carbonized by a certain process, and the successive transformation of these fibers into carbon filaments may be followed in several collections to be seen at Mr. Edison's exposition, and which will gratify the curious and are worthy of study. According to Mr. Batchelor and Mr. O. A. Moses, co-laborers of Mr. Edison and who represent him at the Exposition, the resistance of these filaments is 125 ohms when brought up to

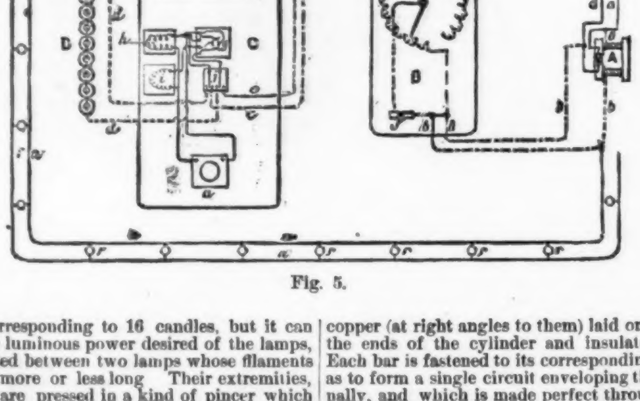


Fig. 5.

an incandescence corresponding to 16 candles, but it can vary according to the luminous power desired of the lamps, for it can be distributed between two lamps whose filaments are correspondingly more or less long. Their extremities, which are enlarged, are pressed in a kind of pincer which terminates the platinum conductors, and which are soldered by an electrolytically deposited copper. Fig. 1 represents the actual arrangement of these lamps. Their duration, from what I have been assured, is long enough; however, they must wear out. Although most of them may have served for 1,200 hours, the question may be asked whether a lamp capable of deterioration may be considered a practical thing, but if it is considered that this lamp can be furnished for thirty cents, that the adjustment on its support cannot be any simpler than it is, which is evident on inspection, it is easily seen there is no more trouble to replace one than to renew a broken lampshade.

What constitutes Mr. Edison's system is not alone his lamps: it is the totality of the arrangements referring to them, and which have attained such a degree of simplicity that henceforth nothing remains to be desired in practice. Generating machines, distribution of circuits, installation, indicating and regulating apparatus, meters for measuring the amount of current employed, are all combined for immediate application, and, as we have said, this application is about being made in a part of the City of New York, where a great number of houses are to be lit by this system by means of a subterranean distribution from a central station, from which also motive power will be distributed to the houses.

This central station will be provided with twelve steam engines of 150 horse power each, actuating dynamo-electric machines, each of which will be capable to supply, it is said, 2,400 lamps of eight candle power. The current furnished to these lamps comes through a branch taken before each house from the large sized conductors laid in the streets. These deviations bring the poles of the generator into each house, where the lamp wires can be brought in connection with them, thus rendering each house independent of any other, both for a supply of light and motive power.

When it is considered that in the system of distribution adopted by Mr. Edison, the total resistance of the exterior circuit is extremely reduced, and that with 2,400 on, it is only 62-2,400ths, say about 3-160ths of an ohm, it can be seen a very feeble resistance should be given to the generating machine, so that its first arrangement has been modified. To begin with, the field magnets were arranged on a derivation taken from the commutators, putting it into the induced circuit as in Wheatstone's and Siemens' system. Then the armature was arranged on Siemens' principle, so that the wire consisted of bars of copper. These bars lie close to each other around the cylinder which forms the armature, and they generate the current. Their extremities correspond to disks of copper (at right angles to them) laid one against the other at the ends of the cylinder and insulated from each other. Each bar is fastened to its corresponding disks in such a way as to form a single circuit enveloping the cylinder longitudinally, and which is made perfect through the coupled bars, two-and-two, with the commutator blocks (made after the Gramme pattern). Figs. 2 and 3 give an idea of this new arrangement. The center of the cylinder itself is occupied outside of the rotating axle by a cylinder of wood, which in its turn is surrounded by a thick tube made of a series of very thin disks of iron, separated from each other by tissue paper. This arrangement facilitates the rapid changes of polarity in the plates. This tube is terminated at its two extremities by two thick clamping disks which are made to compress the others laterally, and the copper disks of the working coil occupy the two compartments at the extremities of the cylinder, as seen in Fig. 2. Under such conditions as these, the resistance of the generator is small and permits of great subdivision of the current in multiple arc; nor is there any insulation to be burned, and it is even possible in

case of the deterioration of the bars to renew them easily, for they are simply screwed against the copper disks corresponding to them. In the new disposition adopted by Mr. Edison, the field magnets lie horizontal instead of being placed in the vertical.

Fig. 4 represents the whole machine as now actually working in the Palais de l'Industrie.

We have described the generating machine before completing the description of the system of distribution of the current, because we ought to speak of the system of control used in making the current uniform when its intensity has been modified by a variation in its distribution, that is to say, following after a variation resulting from the unexpected suppression of a certain number of lamps in a part of the system. The necessities of this system are easily understood, if we consider that this suppression can lead to a greater or less increase in the intensity of the current feeding the remaining lamps.

In France several systems have been devised to obtain an automatic regulation, but in America it seems it is preferred to effect this by the intermediation of an appropriate controlling agent.

In this system, in whose general arrangement we see in Fig. 5, the current which feeds the lamps furnishes a deviation at the machine, *bb*, which enters an electric dynamometer, after having gone through a resistance of 8,500 ohms. The electromotive force should be about 110 volts, and a difference of one volt should correspond on the scale of the indicating apparatus to three divisions; consequently, for each observed increase of intensity a resistance capable of compensating for it should be introduced into the circuit. Mr. Edison has established a circular commutator, *c*, with bobbins of different resistance, which permits of an increase of resistance, not in the lamp circuit, which would lead to a loss of work, but in the circuit of field magnets, which weakens their action on the working coil. From the central station also the condition of the current affecting the lamps can be controlled by means of a testing photometer, which enables us to see how much the intensity of the current must be diminished or increased to correspond to a given luminous intensity. For this purpose the photometer is mounted on a little railroad placed in a dark chamber; under and in front of it is placed a scale arbitrarily divided

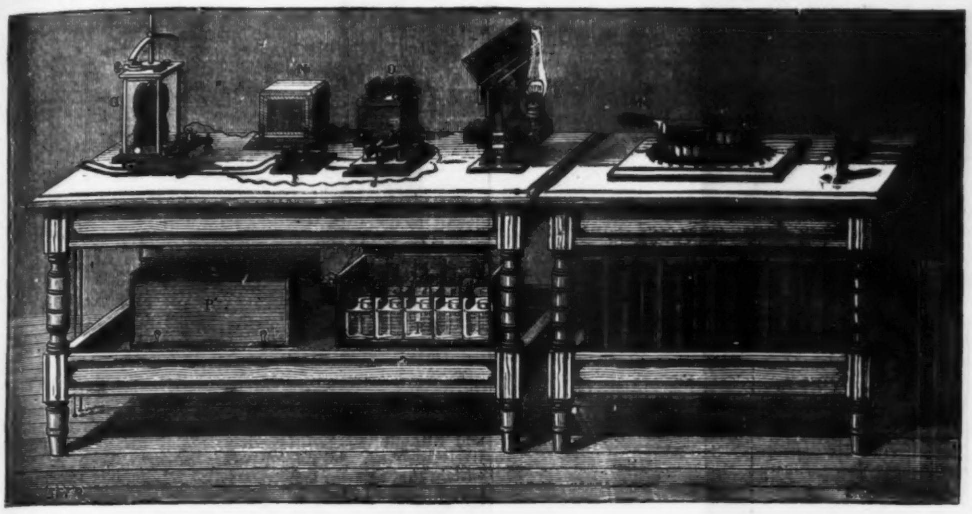


Fig. 6.—EDISON'S TESTING BENCH FOR ELECTRIC LIGHTS.

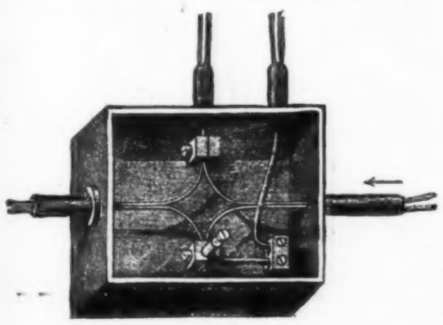


Fig. 7.

so as to indicate immediately the candle power furnished by the current in its normal condition. The left side of Fig. 5 indicates the manner of arrangement of the testing bench with the explanatory table at the bottom of the figure. Fig. 6 shows it in perspective. The manner in which derivations are taken on the principal conductors merits special mention. The conductors are composed of two rods of copper of hemi-cylindrical form, flat on one side and round on the other, which are enveloped in cylinders of insulating material, contained in small wrought iron pipes, which are buried under the streets. To take a derivation the cable is laid bare at the spot where the branch circuit is to be established. The two conducting rods (coming from the main conductors) are cut and bent outward and introduced into a clamp, where they are soldered to the house wires, as shown in Fig. 7; but in order that no harm can be done by two strong currrents, one of these communications is made by intercalating a lead wire in the branch circuit, shown at the bottom of the figure, and which by its fusion interrupts the circuit. This is what is called in America a cut "off;" and in this way it prevents deterioration. The box is then hermetically closed and covered with an insulating coating. In the figure the branch wires are shown double, but it is evident that they could be single.

We said that all arrangements had been made to make the system a perfectly practical one, and of that we will soon be able to judge. Let us examine first how the lamp supports and the lamps themselves are disposed. As has been seen, they are formed of glass globes of ovoid form, cemented into copper sleeves by means of plaster and screwed into cylindrical cavities terminating the supports. These are a kind of arm which can be adapted to brackets or chandeliers or be arranged around the walls. In the last case, the arm, as is shown in Fig. 8, carries two articulations, A and B, and commutations are made by two plates of the hinges which are insulated, and in whose circular part two springs press, seen in Figs. 9 and 10. Connections of the conductors with the lamp, as we have indicated above, are made by a lead wire (cut off), which may melt and interrupt the circuit in case a too great quantity of current should endanger the lamp.

In these brackets, as in the three branch chandeliers, represented in Fig. 11, keys have been introduced which will allow the extinction of the lamps separately or together, without causing any spark at the point of rupture or any danger of fire. The movement of the key, *a*, as shown in Fig. 9, breaks the contact by means of a conical stopper which terminates the screw of the key, and which, when separated from the two plates through which the current passes when the stopper is in contact with them, breaks the circuit at two points, and on a surface of sufficient extent to greatly diminish the spark at the point of rupture.

The lighting of the two salons of Mr. Edison at the Exposition is done by 16 small chandeliers like the above, two grand crystal chandeliers and 80 brackets. Fig. 12 represents one of these chandeliers.

The effect is very beautiful, the steadiness being as complete as could be desired, and if, as I have been assured, the price of this kind of illumination is lower, light for light, than gas, it may be considered that the problem is on the eve of solution, for Edison's system of electric lighting is placed in the same condition as that of gas. He avoids the presence of machines in separate houses, which always are in the way, and which by their very nature require care and management not to be obtained from ordinary servants.

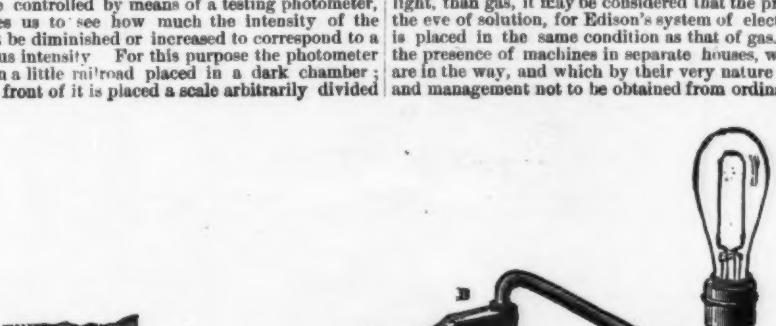


Fig. 8.—EDISON'S ELECTRIC LIGHT BRACKET.

As a complement to this system, Mr. Edison has constructed portable chandeliers, represented in Fig. 13, and a current regulator, shown in Figs. 14 and 15, which permits of reducing the light in any desired proportion. It is a carbon rheostat, composed of carbon pencils of different sections, which, as the current passes through one or the other, allows any desired intensity. The apparatus is enveloped in a cylindrical cover pierced with holes to allow of the escape of heat, and surmounted by a lamp which indicates to the eye the desired degree of luminacy. It is worked by a disk, shown separate in the lower part of Fig. 14, and which can be turned so as to bring a contact spring on any one of the supports of the carbon, whose position is indicated by an index and divisions engraved on the base of the cylinder.

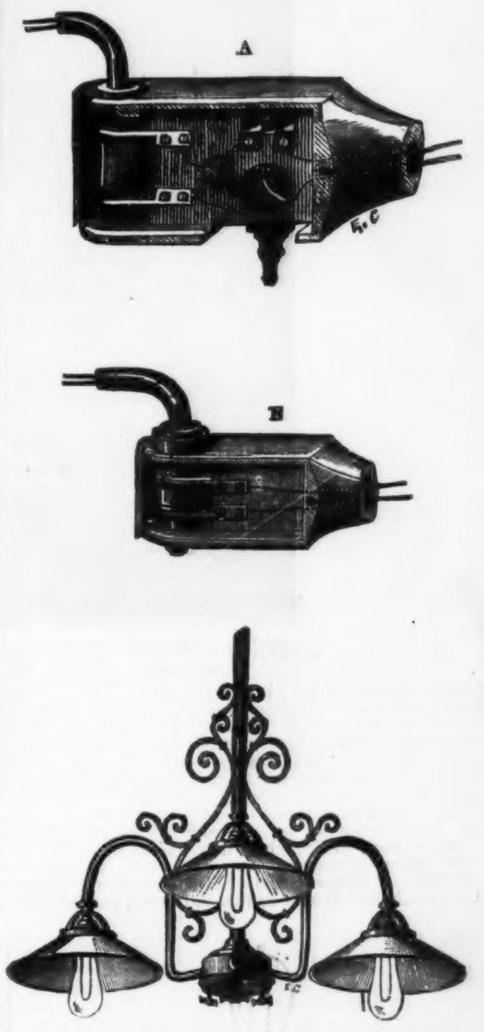
But what is most interesting of all in these accessories of Mr. Edison's system is the meter which determines the amount of electricity consumed by the lamps. There are two kinds: one, automatic like a gas meter; the other requires weighing. They are, however, both founded on the same principle, that is to say, in the estimation of work by the weight of a copper deposit produced by the current used. We will describe these two interesting pieces of apparatus hereafter, and give drawings of them; to-day we must be content with only mentioning the principle involved.

Imagine a balance having at the extremities of the beam two cylindrically rolled plates of copper forming two electrodes. Let us admit that these two systems of electrodes, which plunge into two vessels filled with a solution of sulphate of copper and furnished with fixed electrodes, are traversed in an inverse direction by the current employed, and which can cause the balance to operate under a given weight of copper deposited from the solution. It is easily seen that the movement brought about by these conditions can set in motion a current reverser, which can change the conditions of the deposit in such a way that the electrode covered with copper is transformed into a soluble electrode, while the one which was originally in that condition becomes the reducing electrode. From this time on, an oscillating motion of the beam of the balance is established and more or less frequently repeated according to the rapidity of the formation of the deposit, that is to say, according to the intensity of the current. As the same movement can bring about the passage of a derived current (taken from the total current) across a special electro magnet, which commands the movement of a counter, it is easily seen (after the determination of the number of amperes corresponding to the weight of the deposit, which produces the oscillation of the balance) what is the quantity of electricity consumed.

The realization of this idea has necessitated some electromagnetic arrangements which we will describe in detail when we get the drawings of the apparatus.

The other system is more simple, consisting of two voltameters of sulphate of copper whose electrodes can be easily taken out and weighed, as the work done can be calculated from the weight of copper deposited. One of these voltameters is open to the subscriber, the other is kept closed by the controller. Resistance bobbins introduced into the circuit corresponding to these resistances, permits of the employment of greater or less periods of registration.

A small incandescent lamp placed beneath the apparatus, and which can be thrown into circuit by a simple metallic thermometer, prevents any danger of freezing in extremely cold weather.



Figs. 9, 10, 11.—EDISON'S LAMP CONNECTIONS.

There is another application of Mr. Edison's light which can be seen at his Exposition in a model intended for lighting galleries in mines. In this arrangement, represented in Fig. 16, the lamp is introduced in a glass receptacle filled with water and held in suspension. Communication of the apparatus with the circuit is arranged in such a way that the points of contact are covered by water, which avoids any danger of explosion in mines infected with fire-damp.

To give an idea of the application of Mr. Edison's systems, we have represented in Fig. 17 the interior of a parlor lighted by the small chandeliers previously described. As is seen, the electric light is projected downward, the best arrangement for reading and writing. This method is preferred by Mr. Edison, but, as can be seen above described, all styles of illumination can be produced with this kind of light, analogous to that obtained with candles or gas jets: it is simply a matter of taste.

FIG. 12.—EDISON'S CHANDELIER OF ELECTRIC LIGHTS.

Mr. Edison's lamps are not alone employed in the two salons reserved for him; they are to be found in various places throughout the great nave, notably at the exhibits of Messrs. Heilmann, Ducommun et Steinlen, and at the exhibit of Messrs. Sautter and Lemonnier. At these two places the currents are furnished by two Gramme machines, type A, and each one lights about 40 lamps. Now that Mr. Edison's great machine has arrived at the Exposition it will be possible to obtain with the incandescent system illuminations of greater magnitude. The landing of the great staircase will be lit in this way. It is proposed to accomplish this by means of a crystal chandelier of 144 lamps, and of others furnished with 25 lamps each, to be hung from the different panels, and of girandoles standing on the 16 pilasters of the staircase. This will produce an enchanting effect and a brilliant illumination. I am not quite sure that this mixture of arc and incandescent lights is a happy thought. It is evident that the latter destroy the effect of the former, and might lead one to believe that the luminous intensity of the incandescent lamp is less than it really is. Again, the difference in the color of the light is so contrasted that many persons who reproach the electric light for its ghastly aspect find it too red in incandescent lamps. It is evidently an effect of contrast, for the light of incandescent lamps is whiter than that of gas jets, which, nevertheless, the same people find very agreeable. If required incandescent lamps can give a dazzling white just as well as the others—it is only necessary to employ a stronger electrical intensity—then they lose their peculiar qualities, that of giving a soft light which does not fatigue the eye, and of an easier and more complete subdivision.

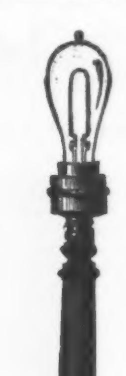
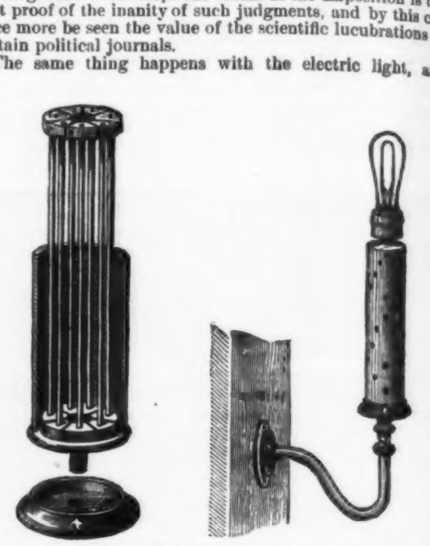


Fig. 13.

It is certainly very difficult to satisfy everybody, and that many persons hardly know what they do want, above all when the effects of contrast momentarily impair the power of judging correctly. On the other hand there are certain fault-finding spirits who are never satisfied with anything; witness the author of that incomprehensible article that recently appeared in a certain journal who pretended that only discordant sounds and puppet show voices could be heard in the telephones from the Opéra. The author in question who could perpetrate such an enormity must have had his ear as sick as his humor. The crowd passing every evening before the telephone rooms at the Exposition is the best proof of the inanity of such judgments, and by this can once more be seen the value of the scientific lucubrations of certain political journals.

The same thing happens with the electric light, and quite a number of persons, without previous examination, and without being of the same opinion two days consecutively, come to us and disparage electric lighting. It is certain that new inventions have great difficulty in coming to light, and in succeeding, above all, when they are opposed by rival interests; but when they are really good, they triumph in time over all obstacles.



FIGS. 14 AND 15.—EDISON'S RHEOSTAT LIGHT.

We would like to give some information about Mr. Edison's new machines, but as they are not yet put up, we reserve the description for another time. We will only say that the steam engine was constructed especially for this application, that it makes no noise, and that the dynamo-electric machine forms one of its integral parts. The field magnet of this latter mentioned, in place of being vertical, as in the model represented in Fig. 4, is horizontal, and the dimensions of the machine itself are much larger.

The steam engine which works the machine is of peculiar construction, and the speed of rotation which is communi-

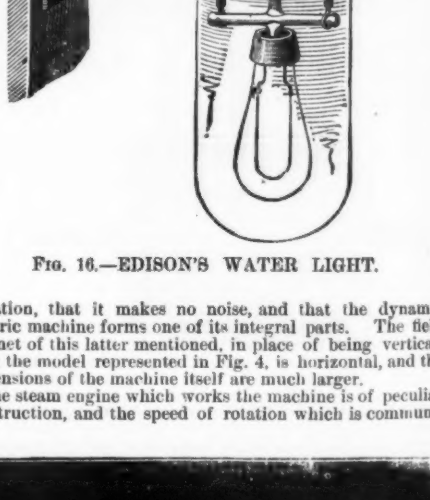


FIG. 16.—EDISON'S WATER LIGHT.

FIG. 17.—EDISON'S PARLOR ELECTRIC LIGHTS.

rated to the working coil is 350 turns a minute. This is not a very great speed, but the armature is very heavy, weighing, as we are told, over three tons and a half. The magnetic field in which it turns is formed by three powerful electro magnets united so as to form but one at their extremities. In the salon of Mr. Edison is a collection of photographs, among which may be seen some of the manufactories where the enormous amount of material required in these installations is constructed. As we have been assured, one of these turns out 2,000 lamps a day, giving occupation to 150 persons. In accompanying drawings and collections can be seen methods of glass blowing, the carbonizing of the filaments intended for incandescence, the vacuum pumps, and the mounting and packing of the lamps. The pumps referred to are set in motion by dynamo electric machines.

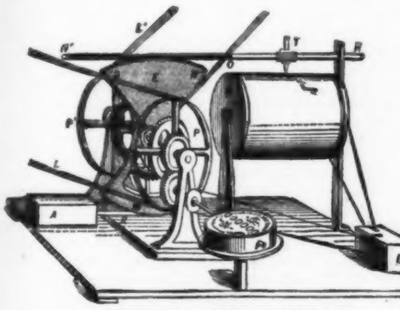
From all this we see Mr. Edison's system to-day is completed, perfectly studied out in all its parts, and that nothing more remains to be done but to introduce it on a great scale.

SMITH'S DYNAMOMETER.

In the English section of the Paris Electrical Exhibition, Mr. Smith, of Taunton, has on exhibition a model of a dynamometer the principle of which is similar to that of the Morin apparatus, as there are two pulleys which, in transmitting motion, act upon a spring and stretch it more or less, according to the stress exerted.

The apparatus is represented in the accompanying cut. The two pulleys, P and P′, which are carried on the same shaft, are loose thereon, and each of them is connected with a bevel-wheel. Between the two pulleys, and loose also on the same shaft, there is a piece, M, in the form of a sector of a circle, and which is hollow in the center. In this open or hollow part there is a third bevel-wheel having a vertical axle, and which gears with the two others, performing, by reason of M being movable around the shaft, the role of a planet-wheel. To the lower part of the sector, M, there is attached a band which is kept continuously taut by a spring inclosed in the box, A. Finally, the sector, M, is prolonged above the shaft by a rod carrying a wooden sector, E. A counterpoise located behind the latter serves to keep it in equilibrium with M.

It is readily conceived that if the pulley, P, is put in motion in a direction opposite that of the hands of a watch, by means of a belt, the three toothed wheels will transmit to the pulley, P′, a rotary motion in an opposite direction, and that this pulley, P′, will be enabled, through the intermedium of the belt, L′, to put in motion the machine to be tested. But if this machine offers a certain resistance to the motion of the pulley, P′, the intermediate toothed wheel, in addition to its transmission of motion, will be



SMITH'S DYNAMOMETER.

displaced to the right and pull on the spring in the box, A; and such displacement will be so much the more in proportion as the stress exerted is greater. In order to ascertain the work performed, it will be sufficient, as in all apparatus of this class, to measure the tension of the spring and the number of revolutions of the shaft. The latter figure is given by an ordinary revolution counter, shown in front of the apparatus. Two toothed wheels of equal diameter, situated between the pulley, P, and the back support of the shaft, transmit motion to the counter.

As for the tension of the spring, that is registered in the following manner. Upon the circumference of the sector, E, there rests a horizontal wooden rule, N′ H, which at H passes through the aperture of a vertical support. Two wires, N N′ and O O′, attached on the one hand to the sector and on the other to the rule, guide the latter in such a way that it follows all the motions of the sector, E, and consequently of the sector, M. The rule carries a movable style, T′, formed simply of a glass tube drawn out to a point and containing colored ink. Beneath this there is a wooden registering cylinder covered with paper. A small pulley on the axle of the counter transmits the motion to an endless screw in the box, B′, and this screw, acting on a toothed wheel, causes the revolution of a second pulley, which is also inclosed in the box, B. A cord passing around the last mentioned pulley finally puts the cylinder in motion. As a consequence of this transmission, the cylinder revolves with a velocity which is always in a known relation with that of the pulleys.

When the spring in the box, A, is stretched and undergoes a certain amount of elongation, the sector, M, being pulled toward the right the rule is carried to the left and the style, T′, displaces itself on the cylinder to an extent which is proportional to the elongation of the spring. During an experiment of *n* seconds, it traces upon the cylinder a curve which represents (counting from the beginning of an initial line) the series of stresses exerted; and the surface of the diagram obtained during this time may serve for calculating the sum of such stresses. The inventor measures the surfaces of his diagrams by cutting them out and afterward weighing them. From the weight of a given surface of the same paper and from the weight obtained he deduces the surface of the diagram.

Another style, not shown in the figure, and which is controlled by an electro-magnet connected with a seconds pendulum, traces upon the cylinder a zigzag line which indicates the number of seconds that the experiment has occupied.

This apparatus, in the form in which it is exhibited, can only be used for low powers; but it may be constructed of larger dimensions and serve to measure a work of five to ten horse power. In such a case the system of pulleys would alone be increased in size, the registering apparatus remaining the same.

We do not believe that automatic registering by means of a cylinder has any practical advantages over the arrangements employed by Messrs. Morin, Ayrton and Perry, and Latchinoff; the apparatus only becomes more complicated thereby, and uselessly so. Mr. Smith's dynamometer, however, possesses one ingenious feature which he might have taken more advantage of; and that is the use of a system of toothed wheels which allows him to place the spring exterior to the revolving portions of the apparatus. By providing this spring with an index projecting out of the box, A, and putting a graduated scale upon the latter, the inventor would certainly have made a simpler and more practical apparatus.—*Journal Universel d'Electricité.*

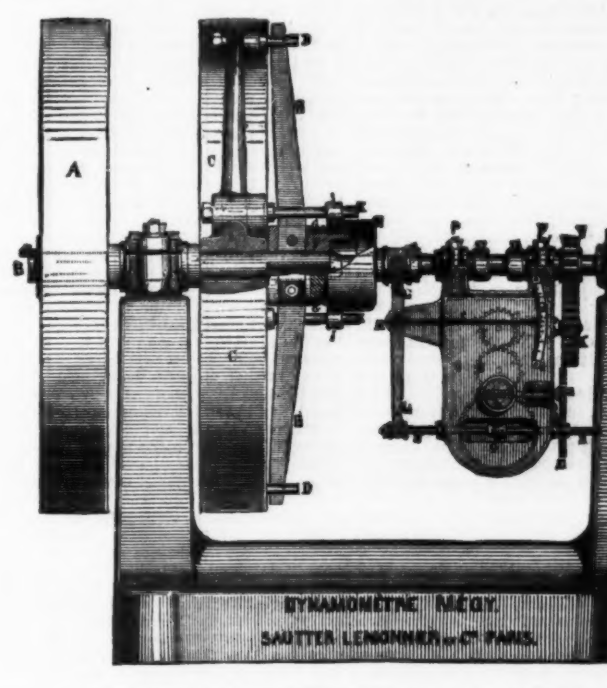
THE MEGY DYNAMOMETRIC COUNTER.

We illustrate herewith the Megy dynamometric counter, exhibited at the Paris Electrical Exhibition by Messrs. Sautter and Lemonnier.

The object which the inventor of this apparatus has had in view has been to construct a dynamometer which should give, at a single reading of the number registered upon the counter, and by multiplying this number by a coefficient, the number of kilogrammes transmitted by the motor to the machine to be tested.

We find first in this dynamometer the two pulleys—one loose and the other fast on the shaft—which figure in the Morin apparatus and those analogous to it. They are mounted upon a shaft, B B, which is supported upon a special frame. One of them, A, is keyed to the shaft, and the other, C, is loose. The latter carries four tappets, D D, against which press four spring plates which are fixed to a sleeve, F, keyed to the shaft.

When the pulley, A, revolves through the medium of the driving belt, it carries along the shaft, B B, and the latter carries with it the sleeve, F, whose springs, E E, coming in contact with the tappets, D D, carry along the pulley, C, and bend proportionally to the stress exerted. It is this bending of the springs that it is a question of automatically registering by the apparatus.



MEGY'S DYNAMOMETRIC COUNTER.

For this purpose there is keyed to the sleeve, F, a brass socket, G, which is threaded externally, and upon which is screwed a brass sleeve, having an internal thread of the same pitch. This sleeve carries two rings, I I, which are traversed by rods, K, that are fixed by means of the loose pulley, C. The socket, G, being fixed to the very piece that carries the base of the springs, and the sleeve, H, being fixed to the loose pulley, it will be seen that every bend of the springs will cause H to revolve upon G, and (because of the screw threads) effect a displacement of H in the direction of the shaft. Such displacement will be proportional to the bending of the springs and consequently to the stress transmitted.

In order to transmit this motion to the registering apparatus, a forked lever, L, guided by a prolongation of H, oscillates around the point, M. This point of support forms part of the frame of the registering apparatus suspended freely around the shaft at P P. The extremity of the lever, L, acts upon a rod, N N, to the center of which is fixed a steel disk, which, when at rest, rests with slight friction against the plate, R, to whose center it is tangent. A toothed pinion, Y, keyed upon the shaft, transmits to the plate, R, through the intermedium of the pinion, X, and of the toothed wheels, T and S, a rotary motion whose velocity is in a given ratio to that of the shaft. Finally, the velocity of the disk's rotation is registered by a counter, *b*, which is put in connection with it by the toothed wheels, *a* and *z*, through which it is possible for the axle, N N, to slide without ceasing to carry along the disk in its rotary motion. When, then, a displacement of the sleeve, H, occurs, the lever, L, oscillates around the axle, M, at an angle which is proportional to the stress; the needle, *c*, indicates on the dial, *d*, the extent of the oscillation and consequently the stress; and, at the same time, the lever, L, by its action on the rod, N N, and the disk, Q, which carries the rod, has displaced the disk from its mean position by a space proportional to the stress. Since, in its mean position, the disk, Q, is in slight contact with the plate, R, at its center, the displacement of the lever, L, results in bringing the disk in contact with the plate, R, at a point distant from the center of the latter, proportional to the stress. If, then, the plate, R, were in motion, it would carry along the disk, Q, by friction, and consequently also the rod, N N, with a velocity which would be proportional to the stress. But, on another hand, this plate, through the intermedium of the pinion, Y, which is keyed to the shaft, B B, and of the wheels, S, T, X, is given a rotary motion whose velocity is proportional to that of the shaft, B B; and the result is that the number of revolutions of the rod, N N, is at once proportional to the stress transmitted and to the space passed over, that is to say, to the work. It is this number of revolutions that is measured by the counter, *b*, through the intermedium of the pinions, *z* and *a*. In order to obtain in kilogrammes the work transmitted, it remains to multiply this number of revolutions by a coefficient which has been determined by a prior experiment. In the apparatus, such coefficient is inscribed upon the spring; and upon the latter is likewise inscribed a coefficient which, multiplied by the number that the needle, *c*, indicates on the dial, gives the stress in kilogrammes.

With the latter datum, if it be desired to verify the instrument, it may be easily done by mounting upon the shaft, B B, an ordinary revolution counter.

This dynamometer may be employed with machines making 1,500 to 1,600 revolutions, and it has already been practically applied to the measurement of the work absorbed by dynamo-electric machines.

In conclusion, when we consider the different apparatus of this kind that have been described, we see that, as regards the work produced by a motor, Prony's brake, and especially the funicular brake, permit of a practical and easy determination of it; but it is not exactly the same with regard to dynamometers designed for measuring the work absorbed by a machine. Among the apparatus of this class, several are very well put together and are excellent for practical use, but they are cumbersome and large apparatus which necessitate a peculiar installation. What is wanting at present is a portable dynamometer that may be easily set up in any workshop whatever for the study of any kind of machine without changing the arrangement of the latter. Mr. Hefner-Alteneck's dynamometer fills these conditions up to a certain point, but requires, however, not only the erection of a support for it, but also a certain change in the tension of the belt. The question, then, remains an open one, and there are still improvements to be made; but, it is to be hoped, in view of the present state of the matter, that these improvements will not be long forthcoming.—*La Lumière Electrique.*

THE EARLY DAYS OF ELECTRIC TELEGRAPHY AND OF OCEAN CABLES.

The following is a summary of a paper by Mr. Willoughby Smith, Vice President of the Society, "On the Earlier Days of Electric Telegraphy," read at the meeting of Electrical and Telegraph Engineers at Paris, on September 21:

Of all the modern applications of electricity, one of the most important is its adaptation to telegraphic purposes. No account of a practical electric telegraph had been published prior to the date of Messrs. Cook & Wheatstone's patent of June, 1837. In the September following the date of their patent, Messrs. Cook & Wheatstone made their first practical experiment on the London and Birmingham Railway, and demonstrated beyond all doubt that as beacon fires and torches had been superseded in 1792 by the aerial or semaphore telegraph, so now the latter would have to succumb to a far more important rival. But, incredible as it may appear at the present time, the contest was long and fierce, and not until 1852 did the final defeat arrive, as far as England was concerned, when the electrical telegraph superseded the semaphore which had so long done duty between Liverpool and Holyhead. Who really invented the electric telegraph is a problem as impossible to solve definitely as who invented railways or steam navigation. Although one could loiter and note many points of interest which occurred in the history of electric telegraphy from its commencement in 1845 to 1850, I fear time will not allow of our doing so; let us therefore pass to the year 1850, and observe what progress had been made to that date.

In England the "Electric Telegraph Company" had extended their wires to 2,215 miles, and were using double and single needle instruments, an important modification of the five and four needle instruments patented by Messrs. Cook & Wheatstone in 1837. In Ireland they had not yet realized the value of the electric telegraph, for, although they had 500 miles of railway, they had not five miles of telegraph wire. But in America they had 12,000 miles of wire, and were using the Morse, Bain, and House instruments, all on the permanent recording principle. In France there were only 620 miles of wire in operation, suspended similarly to

those in England, the instruments used being what were termed revolving pointers. In Prussia they had 2,468 miles of wire, mostly subterranean, and similar instruments were used to those worked by the French Government. In America they were also at this date employing the electric telegraph in their meteorological observations, and had commenced a system of storm warnings along many parts of their coast similar to that we are now so familiar with in England.

Electric telegraphy having made such satisfactory progress, it became absolutely necessary that England (the island center of the commerce of the world) should no longer remain in her isolated position, but be put into direct telegraphic communication with other nations. Consequently, in 1850, a company was formed in connection with the concession just obtained from the French Government by Mr. Brett, for the sole right to establish telegraphic communication between England and France. Mr. Brett had guaranteed that with his instrument one hundred messages of fifteen words each, printed in clear Roman type, should be sent ready for delivery in one hundred consecutive minutes. That was a bold undertaking on the part of Mr. Brett, considering the various opinions held in those days as to the practicability of ever being able to either lay or work a submarine line. Having described the failure of this, the first experimental line of telegraphic communication between the two countries, Mr. Smith remarks:

After careful consideration, it was, in 1851, finally agreed that instead of one wire of the size used in the line of the previous year, four copper wires, 0·065 diameter, covered separately with two coverings of gutta-percha to 0·25 inch diameter, should be twisted together and well protected with thick iron wires laid spirally around them. Owing to litigation as to patent rights, the manufacture of the cable was seriously delayed and not finally completed until September 17, 1851. Preparations were at once made to coil the cable in one length on board the Blazer, a hulk lent by H. M. Government, and on September 24 all was coiled, and the Blazer, in charge of two steam tugs, started for the South Foreland, where on the following day one end of the cable was landed and the laying commenced.

To enumerate the many exciting incidents which occurred on board the Blazer that day would occupy too much of our time. Although the weather was fine at starting, it soon changed, and before noon it was blowing a gale, and the Blazer, helpless old hulk as she was, rolled and pitched most unmercifully. Never had there been such a continuous struggle between mind and matter as there had been the whole of that eventful day, and it was to be regretted that matter for the time gained the victory. But nothing daunted, a sufficient length of cable to reach the shore was at once ordered; and in the meantime three wires were twisted together, and, without any protection, laid to the beach, and there connected to the wires already laid to a room at the railway station at Calais. Thus, on September 30, 1851 (or within a few days of thirty years ago), was telegraphic communication established between England and France. On October 19, the additional length of new cable replaced the three wires, and on November 13 the cable was first used for the transmission of public messages, and with slight interruptions has continued to do so to the present time. The possibility of submarine telegraphy having been so satisfactorily demonstrated, it was but natural that many and various schemes should have been immediately devised for its further development. But, unfortunately, owing to the great haste and total disregard of even ordinary precautions, some of the schemes proved lamentable failures. Three cables had been lost in attempting to electrically connect England and Ireland, but in 1852 a heavy multiple cable was successfully laid from Portpatrick to Donaghadee. Four light cables were also laid in that year between England and Holland, and a heavy multiple one between Dover and Ostend.

The year 1853 was also notable for the large amount of subterranean wires laid in England by several of the then existing telegraph companies. From 1851 to 1856 there had been successfully laid, not in connection with England only, but in various parts of the world, about 1,600 miles of cable, and it was thought that sufficient experience had been obtained to bring to a successful issue the long-cherished scheme of laying a cable from Ireland to Newfoundland, and thus bring America into direct telegraphic communication with England. Experiments were made with long lengths of submarine and subterranean wires, and finally the choice fell on one in which the conductor consisted of a seven-wire strand of copper, weighing 107 lb. per knot, trebly covered with gutta percha, the weight of which was 261 lb. per knot, the external diameter being three-eighths of an inch. The weight in air of the completed cable was 20 cwt., and in water 13·4 cwt. per knot, its breaking strain being about 3·25 tons. Soon after the commencement of the manufacture of the cable, frequent want of continuity in the conductor occurred through imperfections in the copper, from improper annealing and other causes. Unfortunately the cable as manufactured was coiled, not in tanks where it could be kept under water, but where it was exposed to the powerful effects of the sun's rays. The consequence was that the gutta percha became plastic in parts, and the conductor, being forced out, came into direct contact with the serving, which, being dry, acted the part of an insulator, and thus prevented detection while the cable was in a dry state. It was to be regretted that the manufacture of the cable was too far advanced for advantage to be taken of Sir William Thomson's discovery of the great variation in the electrical conductivity of commercial copper, especially in that then being used for the conductor of the Atlantic cable. The importance of that discovery has since been fully realized, not only in every branch of electrical science, but by also enabling a purer copper to be obtained, for whatever purpose required; for, as is now generally known, the higher its electrical conductivity, the purer the copper.

It was not until August 5, that one end of the cable was landed at Valentia and the laying of the cable commenced. Mr. Smith next traced minutely the failures which met the earlier attempts to lay the cable, but adds:

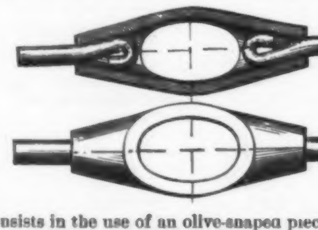
It should not be forgotten that much valuable experience had been obtained, and that the problem was solved as to the feasibility of laying and working an Atlantic cable. It was about this time a cause for surprise and regret that the English Government should have financially connected itself with such a gigantic scheme as that of laying a cable from Egypt to India, while the success or failure of the Atlantic cable was still in the balance. Had they awaited the result of the Atlantic expedition, perhaps the lamentable failure which so soon followed might have been avoided. These serious failures, including as they did the loss of about 8,000 miles of cable, in so short a time, naturally suggested a thorough investigation of the whole matter; therefore a joint committee appointed by the Lords of the Committee of Privy Council for Trade and the Atlantic Telegraph Company was formed to inquire into the construction of submarine cables, and I believe the arduous labors of that committee did much for the ultimate success of submarine telegraphy. In June, 1859, the English Government ordered 1,200 nautical miles of cable to be laid between Falmouth and Gibraltar. The gutta percha on one of the coils having been by accident pierced through to the conductor while placing it in the pressure tank, it was found that the water was forced along the strand and out of the ends which were brought through stuffing boxes for testing purposes. To obviate this in future, I had the center wire of the strand passed through the compound before the other six wires were laid around it. This had the desired effect, as water at a pressure of 1,000 lb. per square inch could not be forced through six inches of a core containing a strand so constructed. This cable was also coiled into water tanks as manufactured; but the ships engaged to lay it were not fitted with tanks, consequently soon after shipment of the first section an increase in the resistance of the conductor denoted an increase in the temperature of the cable, which was found to arise from fermentation, but whether caused by the hemp serving or the oxidation of the iron, opinions differed. Owing to the delay of the ships, the season was too far advanced to lay it where first intended; it was therefore arranged to lay it between Rangoon and Singapore. But the ship carrying the first portion came to grief in the English Channel, and eventually it was laid in three sections between Malta and Alexandria, where, owing to the shallowness of the water in which parts of it were laid, and the light character of its construction, it was frequently out of order, and had to be superseded by a cable which was laid direct from Malta to Alexandria in 1868. On the completion of the first Malta and Alexandria cable, the Government ordered one to be laid in the Persian Gulf. The one selected was to consist of a segmental copper wire, weighing 225 lb. per knot, insulated by four coverings of gutta percha, with the compound already referred to applied in the ordinary way, weighing 275 lb. per knot, the total weight of the core being 500 lb. per knot. The now well-known accumulation method was for the first time applied to test the joints in this core.

Another attempt to connect Ireland and Newfoundland was next made, for during the five years which had elapsed since the last attempt great improvements had been made in every branch of submarine telegraphy. It was accordingly decided to manufacture 2,300 knots of cable, consisting of a core containing a seven wire strand of copper weighing 300 lb. per knot, covered with four coverings of gutta percha and four of compound applied alternately to a diameter of 0·464, and weighing 400 lb. per knot, the total weight of the core being 700 lb. per knot. From the extraordinary care, even to the minutest detail, bestowed on all connected with this cable, it was believed that success would be the reward; but faults occurred in the insulation, which, when found, suggested the horrible thought that the hands of some evil-disposed person or persons had been at work, as there was the undeniable fact that some blunt instrument had been forced between the wires of the outer covering, through the gutta percha to the conductor, and then withdrawn. After various unsuccessful attempts to lay the cable, the expedition returned home, the season being too far advanced to allow of any further attempts being made that year. It was next decided that 1,600 knots of new cable should be manufactured, and in the following year (1866) another trial be made to connect Valentia and Newfoundland, and that then an attempt should be made to pick up the lost end of the previous year's cable, and complete the laying of that cable also. The 1,600 knots of new cable differed somewhat from the former one. The iron wires were more pliable, were galvanized, and no compound used on them or their jute covering. After necessary preparations, the expedition started to recover the lost end of the 1865 cable, and after twenty days and nights' hard struggle with the elements, the end was recovered. After speaking with Valentia, and ascertaining the electrical condition of the whole length to be perfect, the end was spliced to the cable on board, and paying out towards Newfoundland commenced. All proceeded well until within a few hours of completing the laying, when, at 6 A.M., while receiving from Valentia a summary of the news from the *Times* of that morning, a sudden fault in insulation occurred. This was soon found to be on board, so the cable was cut and respliced, and to the credit of all, be it recorded that in less than two hours the fault had been removed and paying out recommenced. At 5 P.M., the same day, the laying of this cable was also successfully completed. No doubt the laying of the one cable, and the recovery and completion of the other, were the crowning achievements in submarine telegraphy, and gave to that branch of our science an impetus that knew no bounds until all civilized countries were connected telegraphically as one nation.

At the present there are at work in all no less than 70,000 miles of submarine telegraph cables. Thirty-three years' experience has taught us that neither the electrical nor mechanical qualities of either gutta percha or copper deteriorate by long working or submersion, and also that the iron wires, when properly protected from oxidation, retain all their original qualities; consequently the best form of a submarine telegraph cable will be that in which these conditions are fulfilled.

JOINING WIRES.

We give, in the annexed figure, a representation of a new system of connecting the ends of telegraph or other wires, which commends itself for its extreme simplicity.



It consists in the use of an olive-shaped piece of malleable iron, open at the two ends, and having in the center an aperture on two of its opposite sides. The ends of the wires, having been introduced into the two end openings, are drawn forward as far as the side apertures, where they are bent upon themselves by means of a pair of pincers. This having been done, the wire cannot pass out again through the opening, and may be stretched as much as need may require. The process is the invention of Mr. Thomas Ellis, of Coatbridge, near Glasgow.

HOW TO CONSTRUCT A BAROMETER.

By A. F. Miller.

At the present time, when so much importance is attached to the science of meteorology that its professors are to be found in almost every land, the recognized and valued agents of many governments, or of extensive and important private enterprises, a few words will not be amiss as to the construction of that most important instrument, the barometer; the sounding-line, so to speak, whereby the meteorologist inquires into the ever-changing conditions of the great aerial ocean which surrounds us on every hand, and obtains an insight into the physical forces by which it is actuated, and the laws by which it is controlled.

I propose as briefly as possible to give simple instructions for the making of a barometer. The instrument has been constructed in many forms, of which I will describe three; the siphon barometer, the portable cistern barometer, and the stationary cistern barometer, leaving it to the reader's judgment to decide which of these will best suit his purpose.

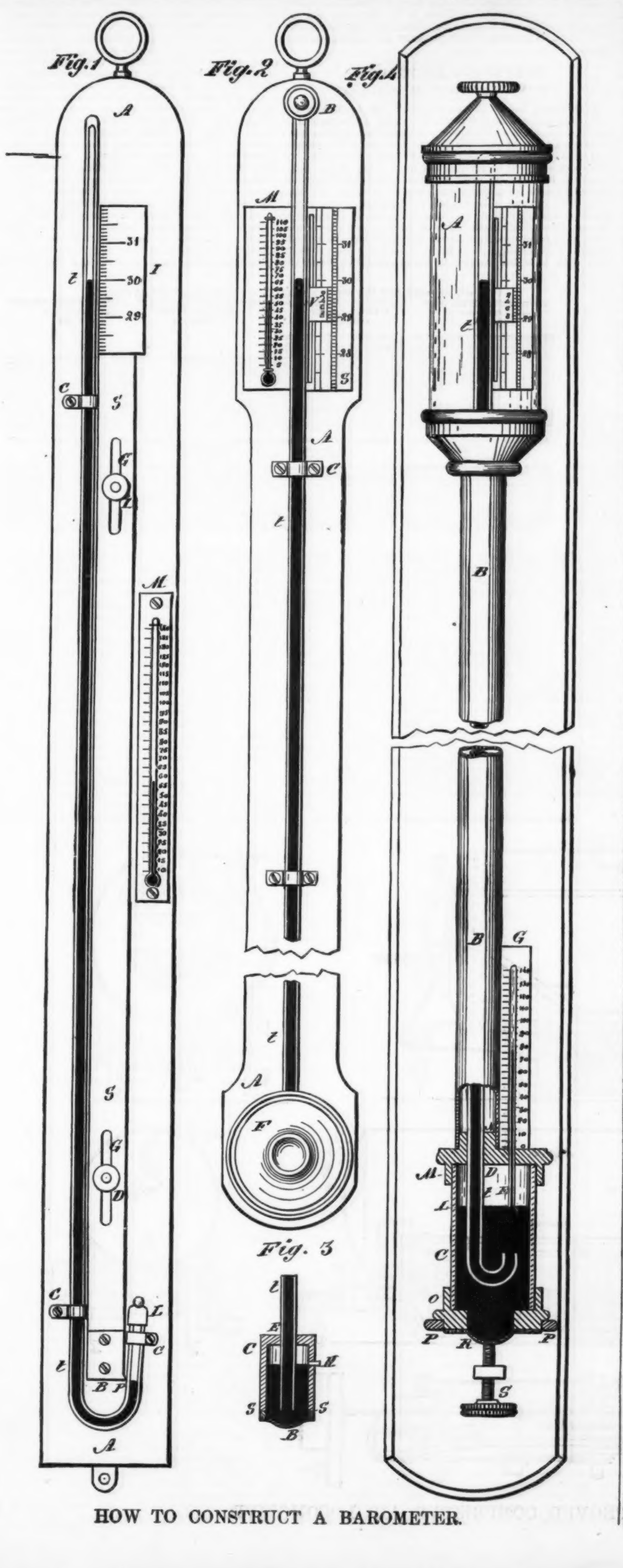
A few words must first be said regarding the selection of the glass tube, as on its fitness for the purpose the instrument's future excellence will very much depend. Ordinary white, easily fusible glass tube should not be used, as the mercury is apt to attract its oxide of lead, and not only become impure, but by adhesion to the inside of the bore hinder the free oscillation of the barometric column. The proper kind of tubing is that which shows a greenish tinge in the glass when looked at endways. For either of the instruments shown in Figs. 1 or 2, it should not be less than ⅜ inch outside diameter and ⅛ inch bore; and if slightly larger may still be used with advantage.

For the siphon barometer, Fig. 1, a piece of tube about 42 inches long is required. This is to be well cleaned by running through it plenty of warm soft water, while at the same time a little swab made from a piece of soft, fine linen, tied in the middle of a cord, is pulled through the bore from end to end. After the water has drained out, alcohol, in which precipitated chalk is suspended, should be applied to the inside by means of the swab. A clean swab, moistened with alcohol, will remove the particles of chalk, when, the cord being withdrawn, distilled water is to be poured through, after which the tube must stand in an upright position till it has drained perfectly dry, a little cap of paper, meantime, being placed on its upper end to exclude dust. The inner surface of the tube must finally be polished with a small piece of soft wash-leather fixed on the end of a clean, smooth brass wire.

The tube thus cleaned and dried is now to be closed at one end by drawing it in two in a gas flame a couple of inches from the extremity. Instructions for sealing and bending glass tubes are given in so many works on elementary chemistry and kindred subjects that it seems superfluous to repeat them here. Suffice it to say that the narrow pointed end, which forms when the tube is drawn asunder, should be pressed and rotated in the flame till a substantial and well-rounded closing has been obtained. Thirty-six inches from the sealed extremity a U-shaped bend is to be made. Care must be taken to make the curve a gradual one, as failure in this respect would not only mar the appearance of the instrument, but might also tend to narrow the bore and make the bend a weak point. The arc of the curve is to be 1½ inches. The longer limb of the siphon is thus 36 inches long, and the shorter one about three inches. The short limb is not to be bent down quite parallel with the longer one, but should make a slight angle with it, to render the subsequent introduction of the mercury more easy. The tube, *t t*, is to have adapted to it a supporting stand, A A, which may be a piece of dressed walnut, 38 inches long, 3½ inches wide, and about ¾ of an inch thick, rounded off at the top and furnished with a brass screw and ring for hanging up. A shallow groove, curved to correspond with the bent tube, is made on the wood. The three small brass clasps, C, C, C, provided for attaching the tube to its support may be readily cut from sheet-brass, polished, bent to shape, and drilled with a hole in each end to receive the appropriate small brass screws. The sliding-scale support, S, S, is a slip of cherry or mahogany, 1 inch wide, $\frac{3}{16}$ thick, and 32 inches long, having two longitudinal cuts, G, G, made therein, through which pass the screws, D, D, which fasten it to the walnut scale and allow of its motion upward and downward. These screws may be of brass, with milled heads, or a cheap and excellent substitute may be found in two of the brass buttons with screw-stems sold for fastening carriage aprons. These are to have their stems passed through the longitudinal cuts, G, G, and screwed into appropriate holes in the walnut support till their projecting shoulders bind on the scale support and prevent it from moving except when required. The bottom, B, of the sliding-scale support is a piece of sheet-brass cut to shape and attached by two small rivets or screws. Its projecting point, P, is used as an index, as will afterward be explained. A scale, I, made of a piece of ivory veneer, 4 inches long, and about 1¼ inches wide, is required for the upper end of the sliding support. This must be carefully and accurately divided into inches and tenths, the lowest inch mark being numbered "29," the next "30," and the upper one "31." It will be well to have the figures and lines done by an engraver; but, if economy be a consideration, the markings can be very well ruled with a fine pen, and after the ink has dried a coat of thin dammar varnish will protect the lines from injury by moisture. The ivory scale is now to be fixed to the sliding support, with the upper end of which its top exactly corresponds. If the measures have been correctly made its 30 inch mark will now be situated exactly 30 inches from the bottom of the brass index. An excellent cement for attaching the ivory to the wood is made of a little isinglass dissolved by heat in equal parts of alcohol and water. The walnut support, A, A, should receive two or three coats of copal varnish. The cherry wood slide, S, S, may either be finished with boiled linseed oil or varnish, according to taste.

All parts of the instrument being thus fitted it only remains to introduce the mercury. For this purpose the tube, *t t*, being detached from the support is placed upon a level table and sustained by small pieces of wire, so that the short limb is uppermost, the long limb lying flat upon the table. The mercury used should be as pure as possible; though if freshly-distilled mercury cannot be had that of commerce may be used, provided it has not become contaminated by lead or kindred metals. A fair test of the goodness of mercury is made by dropping a little into a clean white plate and causing it to run about. If bright round globules are formed, which readily coalesce and leave no trails of discoloration on the china, the metal is sufficiently pure. If, however, the drops become pear-shaped and soil the plate with dull, metallic splotches, the metal must be rejected.

Before being used for filling, the mercury should, in any case, be forced through small pinholes in a piece of thin



HOW TO CONSTRUCT A BAROMETER.

chamois skin to remove mechanical impurities. It must then be caused to boil for a few moments in a thin glass flask or large test-tube, so as to expel moisture and air. While still hot it is to be introduced by successive portions into the open end of the short limb, through a small glass funnel, the stem of which has previously been drawn to a rather fine orifice and bent in an L-shape. By slightly agitating the tube, any bubbles of air adhering to its inner surface may be dislodged and caused to pass upward through the bend and so out. When the metal has risen to within an inch of the orifice, this is to be loosely closed with a small cork, and the tube being lifted up and sustained with the sealed end a little downward, the contained mercury must be made to boil inch by inch, beginning from the closed end throughout the entire length of the longer limb and curved portion, by means of a large spirit lamp flame *over* (but not *through*) which it is made slowly to pass.

In the last-mentioned operation some caution is necessary to avoid cracking the tube; though with moderate care there is no danger of this casualty happening. The boiling process effectually expels any particles of air adhering to the mercury or the inside of the tube (a most essential element as regards future accuracy in the barometer), and when the tube has cooled the metallic column will be found to present a surface perfectly bright and without speck or flaw. The tube being now raised gently into a vertical position, with its closed end uppermost, the mercury will descend a few inches, showing the Torricellian vacuum in the upper part of the longer limb, while at the same time it rises and overflows from the open orifice of the short limb. From the latter enough of it should be displaced, by inserting a small round piece of wood into the bore, to leave a couple of inches empty. After this it only remains to finish the instrument by attaching the tube, *t t*, to its support with the brass clasps, *c*, *c*, *c*, and screws. A narrow strip of green surface paper, 4 or 5 inches long, slipped behind the upper part of the tube where the vacuum appears, is an improvement to the look of the instrument and an assistance when taking the readings. It will now be evident at a glance that by bringing the point, P, of the brass index, B, level with the surface of the mercury in the short limb, as often as an observation is to be made, the height of the mercurial column in inches and decimals will at once be shown on the ivory scale.

A small thermometer, M, fixed beside the sliding scale is at once a useful and ornamental addition to the barometer. A small cap, L, of metal or wood must be loosely fitted over the open end to exclude dust.

The style of barometer just described, while possessing many advantages as regards simplicity of construction and uniformity of working, has yet the drawback of not being very portable. As some may require an instrument which will admit of being readily carried about from place to place, I give a few particulars in regard to the making of a cistern barometer. These hints, in connection with the instructions already given, will enable those who may so prefer to construct an instrument of the portable kind.

The tube must be cleaned as already described and closed at one end; but instead of being bent is left straight, and cut off at a length of 36 inches. Fig. 3 shows a section of the cistern, which is simply a small wooden cup turned neatly out of hard maple; its outside dimensions being $1\frac{5}{8}$ inches diameter and $2\frac{1}{4}$ inches high, and the inside cavity being $1\frac{1}{8}$ inches in diameter, and 2 inches deep. A cut made with a fine saw along the line, S S, separates the underneath part of the cistern as a small wooden ring, R R, to which is then to be glued a piece of stout wash-leather, B B, made loosely convex so as to bulge readily inward and outward, forming the cistern-bottom and supplying a movable surface on which the atmospheric pressure is to act. A hole, E, in the closed top admits the tube, *t t*, which passes down into the cistern till its end is level with the line of division, S S, and is secured in place by being cemented where it goes through the wood of the top. A small hole, H, for adjusting the height of the mercury is made half an inch below the closed top of the cistern, and stopped for the time with a little wooden plug.

The filling with pure warm mercury is to be done as already described in the case of the siphon, except that the tube may now be placed in a nearly vertical position with its closed end downward; a small straight funnel is to be used for pouring through. The subsequent boiling in the tube must also be performed as before directed; but as the part of the tube within the cistern cannot be exposed to heat it will be best to leave the last few inches empty till the boiling has been finished, when this portion may be carefully filled with hot mercury. The cistern, which, of course, owing to the position of the tube, is being held top downward, is also to receive as much mercury as will fill it to the edge, S S, after which, the ring-shaped piece, R R, bearing the wash-leather bottom, B B, is coated with glue on its sawn surface and pressed on in place, so closing the cistern. As soon as the glued joint is firm, the tube may be turned up into proper position by placing the finger on the wash-leather bottom and pressing it inward till the orifice of the tube is felt, when the whole is quickly inverted. Thus no air enters the tube during the moment of turning over; and as an instant later its opening is covered by the mercury of the cistern, the vacuum is now secured. Care should be taken, however, never again to turn the cistern bottom upward. The tube being now in a vertical position, the level of the mercury is adjusted by removing the plug from the hole, H, when the superfluous metal escapes and the column in the tube descends, leaving the vacuum above. The plug is then to be reinserted and glued in place.

The stand (which it is well to make and fit to the tube before the latter is filled) is so plainly shown in the figure (Fig. 2) that description is almost unnecessary. It may be of walnut, mahogany, or cherry, and its general style and finish must depend on the taste of the maker. A shallow groove down its center receives the tube, *t t*, and an oblong cavity at the botton admits the back of the cistern, while its front may be covered with a hollow ornamental turning, F, as represented. The scale, S S, which in this case should be 5 inches long, may be ruled on ivory as already suggested, though an instrument of this description is really deserving of a well-made engraved scale, with a vernier giving readings to the hundredth part of an inch. Such a vernier, V, is a narrow piece of ivory twelve-tenths of an inch long, provided with a groove to receive the inner edge of the ivory scale along which it slides next to the tube, a hollow being cut in the wood of the stand behind the scale to admit of its motion. It is divided into eleven equal parts by ten horizontal lines numbered downward from one to ten, each of the divisions measuring therefore $\frac{1}{10} + \frac{1}{110}$ of an inch. The method of reading with the vernier is very simple, but space will not admit of its being explained here. It can, however, be readily learned from almost any work on meteorology. The 30 inch line of the scale is to be placed exactly 30 inches above the center of the hole, H.

which marks the level of the mercury in the cistern. It is best to affix the scale to the stand by little brass screws. A small thermometer, M, opposite the barometer scale adds to the elegance and efficiency of the instrument. A slip of green surface paper should be pasted in the groove behind the tube before the latter is fixed in place. The top of the tube, *t t*, should be covered by a small turned button, B, of bone or wood.

For the assistance of those who possess enough mechanical skill to attempt the construction of a very accurate barometer, such as is required in observations for meteorological records, a few hints may be ventured upon. The tube for such an instrument should be larger in internal diameter than the size given for the simple barometer heretofore described; as thus the correction for what is known as capillarity will be reduced and greater accuracy insured. Much care should be taken as to the quality of the glass, and, I need hardly say, as to its inward clearness. It is to be closed at the end, and bent so that the long limb shall measure 37 inches; but its curve must be of much smaller diameter than that of the siphon tube in Fig. 1; in fact, the distance between the two limbs should not exceed half an inch. The short limb is to be half an inch in length. The object of this turned-up portion which, as the figure (Fig. 4) shows, is immersed in the mercury of the cistern, is to prevent the gradual introduction of particles of air into the vacuum by the oscillations of the mercurial column, a result likely to happen in all straight tube barometers when used during long periods of time. The cistern, C C, Fig. 4, is made from a piece of stout tubular glass, 2 inches in diameter and 4 inches long. Its top, M N M, and bottom, O O, are of any firm dry wood, turned with cavities to fit the ends of the glass body and firmly cemented thereto. The top, M N M, has two holes, D and E; the more central one, D, admitting the barometer tube, *t t*, while through the other passes the stem of the attached thermometer, G, for giving the temperature of the contained mercury. The projecting neck, N, of the cistern-top, M N M, enters and sustains the brass tube, B B, 25 inches long and 1 inch in diameter, which serves to protect the barometer tube, *t t*, as well as to sustain at its upper end the wooden piece, A A A, which steadies the vacuous part of the glass tube, and supports the scale fastened on by screws. The bottom turning, O O, of the cistern, C C, is annular in form, its ring-like edges having glued to it the concave wash-leather cistern-bottom, R. The shoulder, *f f*, rests in a stout brass support, P P, screwed to the board which sustains the instrument. A surface or zero mark, L L, is made with a file on the outside of the cistern glass, 1½ inches below the top, giving the standard to which from time to time, when observations are being made, the height of the mercury in the cistern may be adjusted by the milled screws. The instructions for filling the siphon tube above, give with sufficient accuracy the steps to be taken when introducing the mercury in this case. Only recently distilled pure mercury must be used, and the boiling and other operations should be done with the utmost care and attention to detail. The cistern, filled to a little below the zero mark with mercury, receives the curved end of the tube, *t t*, after the filling and boiling have been accomplished. The top, M N M, is then passed down over the tube and cemented in place, and the other parts put together. The adjustment of the position of the scale is made by measurement from the zero mark, L L, on the cistern glass. An amateur should not attempt to make the scale. This work should be intrusted to a good engraver, or, better still, a scale and its vernier purchased at the shop of an instrument maker. The woodwork of the cistern and scale support looks well blackened and polished. The brass tube should be burnished and its surface polished with suitable lacquer.

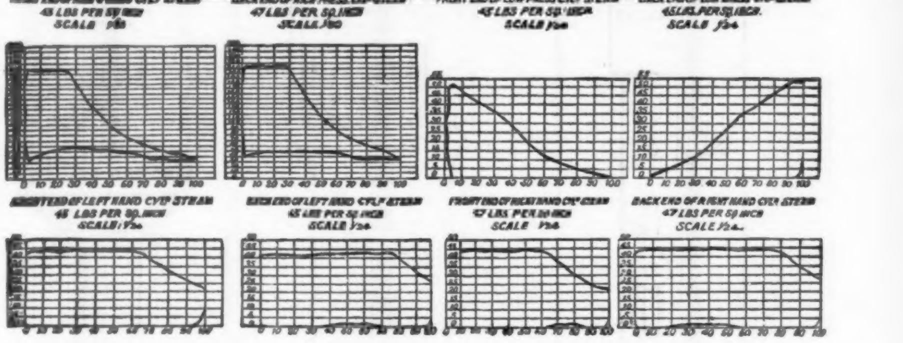
Either one of the instruments I have described constitutes a useful and ornamental addition to the furniture of a hall or sitting room, and if made the subject of daily observation will afford its possessor much pleasure and instruction combined.

COMPRESSED AIR ENGINES.*

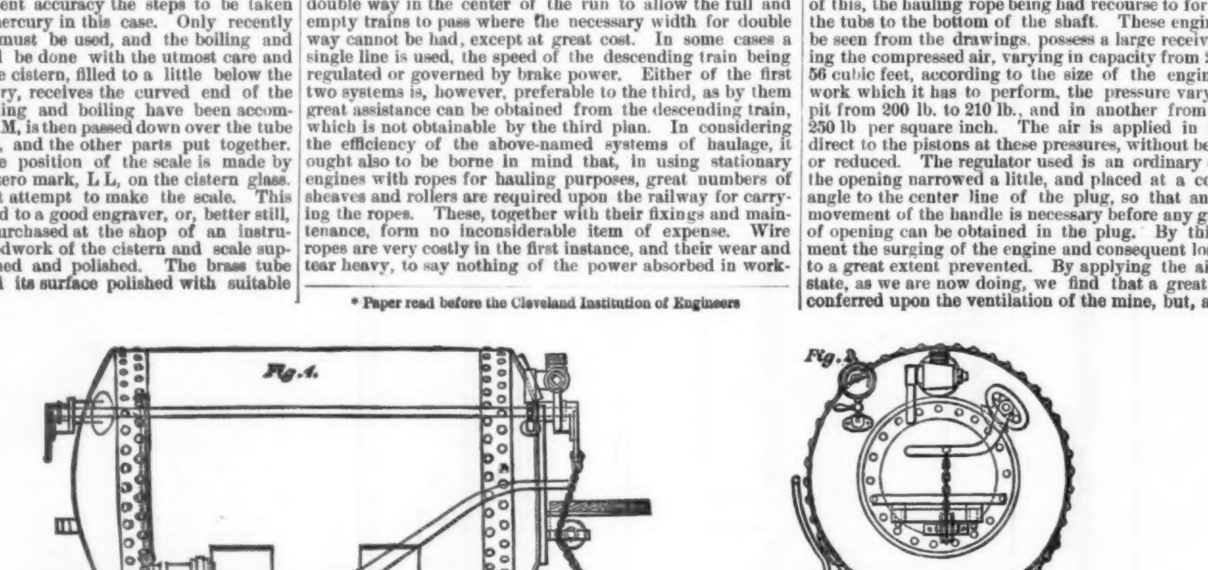
By MR. JAS. YOUNG, Fence Houses.

IN bringing before the members of this institution the following paper, I do not pretend to give a complete theoretic explanation of the various systems employed in compressing air, seeing that this question has been so exhaustively discussed lately in the *Engineer* and other papers, but will confine myself to the discussion of some of the more practical questions involved, in connection with its application as a motor for underground haulage in mines, as compared with the cost of horses and ponies doing similar work. Small stationary engines working with ropes, as made by Messrs. Fowler, of Leeds, Messrs. Tangye, and others, and worked by compressed air at a moderate pressure, have been employed for hauling purposes in mines for several years past with tolerable success in certain districts, where the floor of the mine is very uneven and subject to steep inclines, the method of working such engines being arranged in various ways, such as having main and tail rope drums, and double way the whole length of the run. Three lines of rails are sometimes used, having a sufficient length of double way in the center of the run to allow the full and empty trains to pass where the necessary width for double way cannot be had, except at great cost. In some cases a single line is used, the speed of the descending train being regulated or governed by brake power. Either of the first two systems is, however, preferable to the third, as by them great assistance can be obtained from the descending train, which is not obtainable by the third plan. In considering the efficiency of the above-named systems of haulage, it ought also to be borne in mind that, in using stationary engines with ropes for hauling purposes, great numbers of sheaves and rollers are required upon the railway for carrying the ropes. These, together with their fixings and maintenance, form no inconsiderable item of expense. Wire ropes are very costly in the first instance, and their wear and tear heavy, to say nothing of the power absorbed in working them, an idea of which may be formed from the following statement, made by a committee of the North of England Institute of Mining Engineers in 1867–68, who were empowered to inquire into and report upon the various systems of haulage then in use in this country. After much inquiry and careful investigation, it was found by these gentlemen that in actual work the rope system absorbed as much as from 38 to 45 per cent. of the total power applied.

It must also be borne in mind that the cost of labor and of material is greatly increased since 1867–68, say not less than 15 per cent. Having thus briefly described the various systems of rope and chain haulage then in use, I will now proceed to describe another system of haulage, which is patented by "Lishman and Young," and which has been in use in some of the Earl of Durham's collieries for the last three years with very satisfactory results. By this arrangement small locomotive engines of suitable design are worked by compressed air. They are made by the Grange Iron Company, near Durham, as illustrated by the engravings. [We take our cut from *Engineering*.] The smaller type of engine is that usually employed upon short runs of 400 to 500 yards in length, and for doing the work of horses and ponies generally, such as collecting the full tubs and distributing the empties among the men who are working in various parts of the mine—the full tubs being placed on the flat or landing at the end of the main road, where they are made up into trains, or sets, to be taken away by the large locomotives, or, where the gradients are too steep to admit of this, the hauling rope being had recourse to for conveying the tubs to the bottom of the shaft. These engines, as will be seen from the drawings, possess a large receiver for storing the compressed air, varying in capacity from 20 to about 56 cubic feet, according to the size of the engine and the work which it has to perform, the pressure varying in one pit from 200 lb. to 210 lb., and in another from 220 lb. to 250 lb per square inch. The air is applied in most cases direct to the pistons at these pressures, without being heated or reduced. The regulator used is an ordinary cock, with the opening narrowed a little, and placed at a considerable angle to the center line of the plug, so that an extensive movement of the handle is necessary before any great extent of opening can be obtained in the plug. By this arrangement the surging of the engine and consequent loss of air is to a great extent prevented. By applying the air in a cold state, as we are now doing, we find that a great benefit is conferred upon the ventilation of the mine, but, at the same



* Paper read before the Cleveland Institution of Engineers



IMPROVED COMPRESSED AIR LOCOMOTIVE.

time, we are aware that a considerable loss of work is sustained from a given quantity of air, as experienced by the Pneumatic Tramway Company, of New York, and as reported by General Herman Haupt, who says they do not now apply the air cold. It is admitted into a tank placed on the front platform of the engine, containing five cubic feet of water drawn from a stationary boiler under 80 lb. pressure, and having a temperature of 328 deg. Now, if air is admitted to this tank at 60 deg., and leaves it at 328 deg., the increase of temperature will be 328—60 deg.=268 deg. To raise 1 lb. of water from 32 deg. to 212 deg., or 180 deg., requires as much heat as would raise 4·27 lb. of air through the same range. The specific heat of air as compared with water being as 2·337 to 1, 1 lb. of air increases in volume by heat from 12·387 cubic feet at 32 deg. to 19·824 cubic feet at 328 deg.=7·437 cubic feet increase, showing a decided advantage in heating the air. There are, however, mechanical difficulties to be encountered in the mine which do not exist upon a tramway, and which would in many cases exclude the introduction of heated air. In working pneumatic apparatus much inconvenience has frequently been experienced from the heat evolved in compression, and, again, from the intense cold resulting from expansion, which deposited ice in the cylinders, and blocked up the ports when moisture was present, as it generally is in air in its ordinary condition. It has been stated by writers on pneumatics that 1 lb. of air at one atmosphere and at 60 deg. temperature compressed to two atmospheres is heated 116 deg., and the units of heat evolved per pound are 0·238 × 116=27·6 units. Conversely, the expansion of air caused an absorption of heat, or is productive of cold to a corresponding extent. Ordinary atmospheric air contains more or less water, which on reduction of temperature below the dew point is deposited, to a certain extent, on a cold surface. And when a large volume of air is compressed into a small volume, or, say, to 15 or 20 atmospheres, as in our case, a large percentage of the water is given up and removed. The air being now completely dry, does not, when expanded in the engine, deposit any ice, because there is so little water contained in it to produce ice. This fact has excited great surprise among observers, that so little frost was found, and that principally upon the outside pipes from the condensation of moisture—a lower pressure of 150 lb. to 170 lb. per inch being more favorable to the formation of frost than when the full pressure of 15 to 20 atmospheres is maintained.

The size of cylinders in use for the small engines is 3 in. in diameter by 6 in. stroke, and their receiver capacity from 20 cubic feet up to 30 cubic feet. The cylinders are fitted with ordinary slide valves, arranged to cut off at about half-stroke, one eccentric being used for each engine, or two in all, without any link or other reversing gear. The eccentrics being loose upon the shaft, they are held in position by wrought-iron tusks, which are forged solid upon the shaft, and the reverse motion is obtained by the engine being moved a few inches by hand in the direction it is intended to run. The wheels are 12 in. in diameter, and are made of ordinary cast iron coupled and fitted with a brake, which is worked by the foot at one end of the engine, and by hand at the other, the wheel base being 17 in., and gauge of road 24 in. This short wheel base is necessary to enable them to pass round the sharp curves, which vary from 6 ft. to 7 ft. radius, and to enter any part of the mine where work is going on, and where they may be required. In taking the empty train into the mine the driver is seated in the first tub, having the engine regulator and brake lever within easy reach to enable him to regulate the speed of his train. This is rendered the more necessary from the undulating nature of the roads upon which some of the engines are at work, the gradients varying for short distances up to 2½ in. per yard. When engaged with a full train the driver is seated behind the engine, but having the same facilities for regulating the speed of his train. Owing to the extreme simplicity of the engines, they can easily be managed by a boy of sixteen years of age after a few hours' instruction. An engine of this class was put to work in the western part of one of the Earl of Durham's pits, where the average distance it had to run was 298 yards, the gradient being slightly in favor of the load, and under these conditions conveyed about 150 tons of coal daily to the shaft bottom at a cost of 1·59d., or a little over 1½d., per ton per mile, including all stores, wages, and wear and tear. In comparing the cost of horse haulage with the air engine, it is fair to assume that a pit may be worked eleven days per fortnight, and that a horse travels upon an average 14 miles per day, and upon a road similar to that upon which the above engine was working, his load would be four tubs, 21 of which would make 9 tons of coal, and the distance being put at half a mile into the landing, and half a mile out, would give one mile per trip, or 14 trips per day, which with overweight of coal in tubs, would equal, say, 24 tons; then 24×286×0·5=3,432 tons led per year over a distance of one mile, at the following cost per horse:

	s.	d.		£	s.	d.
Hay and corn....	12	10½	per week,	33	9	6
Harness and depreciation..........	5	0	"	18	0	0
Attendance and farrier........	1	9	"	4	11	0
Driver's wages....	1	4	"	19	1	4
				70	1	10

$$\text{Then } \frac{70\text{—}1\text{—}10}{3{,}432} = 4\cdot9\text{d. per ton per mile.}$$

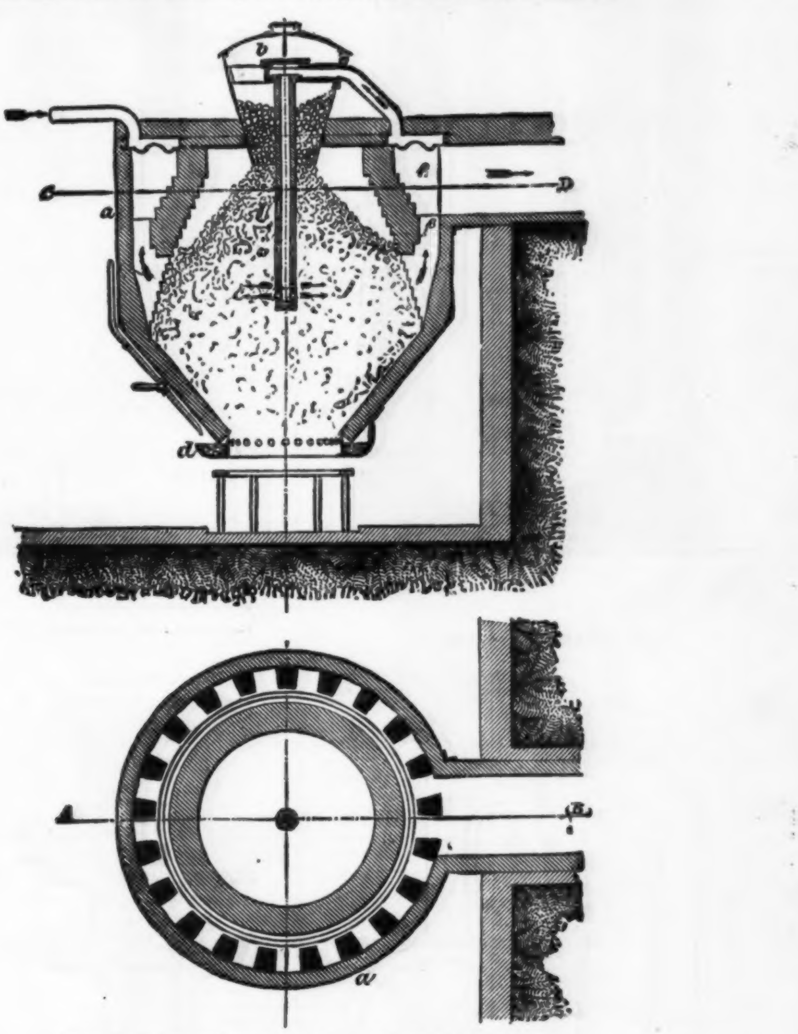
The above calculation is based upon the assumption that the horse is at work eleven days out of the twelve each fortnight, which is putting it under the most favorable conditions, seeing it frequently happens that, from bad trade and other causes, the colliery does not work more than from eight to ten days per fortnight, the cost for maintenance, etc., of horses remaining the same, whether working or idle, which goes considerably against the horse and in favor of the engine. The total weight of engine is 19 cwt.; pressure of air, 200 lb. to 210 lb. This pressure was applied to the engine before leaving the shaft bottom with the empty train, and enabled it to finish the round trip without any further supply, leaving a reserve pressure of about 80 lb. at the finish after landing the full train.

Where the gradients are moderate, and do not exceed ¼ in. per yard—or, say, 1 in 48—against the load for short distances, with intervening levels or slight inclines in favor of the load, they are capable of working a train having a gross weight of four tons over a distance of 400 to 500 yards with one charge of air, but, as a matter of course, they can do very much better upon a level road. Their adhesion, I am inclined to think, exceeds considerably that which is generally considered due to an ordinary locomotive engine, which is found by the usual formula: $\frac{d^2 P l}{D} = T$, where d is the diameter of cylinder in inches, P the mean effective pressure in pounds per square inch upon the pistons, l the length of stroke, and D the diameter of the driving wheel, and T the tractive force at the rails (dimensions being taken in equal terms of measurement whether in feet or inches). The extra adhesive power referred to above may probably be accounted for by the fact of the rails being generally in a dry and gritty condition. I would here remark that the smaller the engine and the shorter the run, it follows, as a necessity, that the expense must be greater than with the larger engine and a heavier load, as there is much more time occupied in charging. The larger type of engines, as at present in use, have a pair of cylinders 4½ in. in diameter by 10 in. stroke, and 20 in. coupled steel wheels. The receiver in this case has a capacity of about 56 cubic feet. It will be seen from the drawing that the general appearance of these engines is similar to the smaller ones already described, except that the machinery is differently arranged, having suitable reversing gear, which is worked from the footplate at one end of the engine only, where the starting and brake handles are also placed, so that the attendant has the whole of the gear under his immediate control. A strong canopy is placed over the working platform to protect the driver from injury by the falling of stone or derailment. It is found by experience that one of these larger engines is capable of running a train of 30 tons gross weight over a distance of 500 yards upon a level road with one charge of air.

The method of compressing the air and delivering it to the locomotives is now to be described. First, as to compressing the air. This is accomplished by a pair of high-pressure steam engines, having cylinders of 30 in. diameter by 7 ft. stroke, fitted with common slide valves and expansions at each end of the cylinder—steam being cut off at about three-quarter stroke—and the weight of the flywheel being 30 tons. The compressing cylinders are 34 in. and 20 in. in diameter respectively, and, being placed in line behind the steam cylinders, have an equal stroke with them under a steam pressure of 45 lb. per inch above atmosphere—the proportion of air cylinders here named having been adopted with a view to securing an equal amount of work from each engine. We have found, however, by experience, that to have made the high-pressure cylinder one-fourth the area of the low-pressure would have given a better division of the work, more especially in view of higher pressures being used, 53 lb. to 55 lb. per square inch being generally obtained under ordinary conditions in the low-pressure cylinder, with but little variation whether the high-pressure cylinder is working at 200 lb. or 250 lb. per inch, the air being passed from one cylinder to the other, and thence into a receiver 24 ft. by 4 ft., made of steel plates ⅝ in thick, double-riveted all over. This receiver is connected with the main pipe, which is 6 in. in diameter, for conveying the air down the pit and into the mine. From the bottom of the pit the air piping is continued along the main road to the flat or landing, but, in places where the distance does not exceed 400 to 500 yards, no such pipes are required, suitable filling stations being erected at the various points where required. The filling apparatus consists of a stand pipe, which is secured to the main air pipe in a vertical position, and is fitted with a swinging bracket after the manner of a double gas braskat 1¼ in. bore. When an engine is brought opposite the stand-pipe to be filled, the bracket arm is swung round after the manner of a watering crane upon the railway, but, in this case, it is attached to the receiver by means of an ordinary union joint with a quick-threaded screw. The taps are then opened between the main air pipe and the engine receiver, when a fresh supply of air is obtained in about 8 to 10 seconds for the small, and about 15 to 18 seconds for the larger ones, when they are again ready for work. This operation is necessary 4¾ times per hour when the engines are in full work, so that the whole time occupied in filling will be considerably under one quarter of an hour per day for each engine at work. It may also be stated here that it is unnecessary to run the engines to any particular place or part of the mine to stand over-night after the shift is done—and this, by the way, sometimes extend to 16 hours' work—they are left standing at their various stations, so that filling them up with air and oiling are all that is necessary in setting them to work again, the compressing engines being started early, and in time to have the pressure in readiness for the locomotives.

SIEMENS' NEW GAS GENERATOR.

Dr. C. W Siemens has been forced, at the Krupp steel works, to recognize the shortcomings in the operation of his gas generators. In a small pamphlet, translated by Mr. Gustave Richard and published by Gauthier-Villars, Dr. Siemens describes, among other things, without, however, saying that it has as yet been constructed, a new gas generator which, without any loss of the simplicity of the first apparatus, will furnish a gas of a greater calorific power. We give an illustration of it herewith.



SIEMENS' NEW GAS GENERATOR.

This generator consists of a cylindrical boiler-plate chamber, a, conical at its upper part and lined with fire-bricks. The hot combustible gases flow, in the first place, through the flues, e, into the annular space, f, and from thence through the pipe, D, to the outlet. Over the generator there is a circular air-inlet which forms a sort of cover. The air becomes heated by flowing through the annular space, and afterward enters a pipe arranged in the direction of the axis of the generator and designed to lead the hot air into the very midst of the mass of fuel in combustion so as to burn up all the carbureted matters that have traversed the zone of greatest heat. The water in the ash-pan, d, after being vaporized by the ashes, rises through the incandescent mass and becomes converted, by decomposition, into carbonic oxide and hydrogen. The intensity of the heat in the very center of the mass of combustible hastens the distillation, and is thus possible, according to the inventor, to double or even triple the product of the apparatus.

Where the Colors Came From.—A Detroit man received from Japan a couple of Japanese hand-made illustrated books. The illustrations were finely colored. The Detroiter was particularly struck with the brilliancy of two of the colors. He saw that the Japanese had evidently some secrets in the color line that were worth having, so he wrote to his friend in Japan to see the book-makers, and if possible find out where they got their colors and purchase some to send to Detroit. Yesterday, says the *Free Press*, an answer came from Japan. The gentleman there found where the colors were sold, and on making inquiry at the paint shop, he found that one of the colors came from Basle, Switzerland, while the other came from America.

ON THE APPLICATION OF SOLID STEEL TO SMALL-ARMS, PROJECTILES, AND ORDNANCE MANUFACTURE.

By MR. M. F. GAUTIER

THIS paper, lately read before the Iron and Steel Institute, was intended to give the results obtained with cast steel containing silicide of manganese. The steel with silicide of manganese, besides the security which it presents in its homogeneity, preserves, when it has been hammered or rolled, an increased limit of elasticity, with a strong tearing strain and a good elongation. It is not necessary to seek for anything more in the manufacture of the barrels of guns. M. Nobel, who worked quite recently at the manufactory of arms at Ijef, near to Perm, has used steel with the silicide of manganese, made according to the process of Terrenoire, in the manufacture of the barrels of guns for the Russian army. The steel without blowholes in small ingots is drawn under the hammer alone. It then possesses the following mean composition:

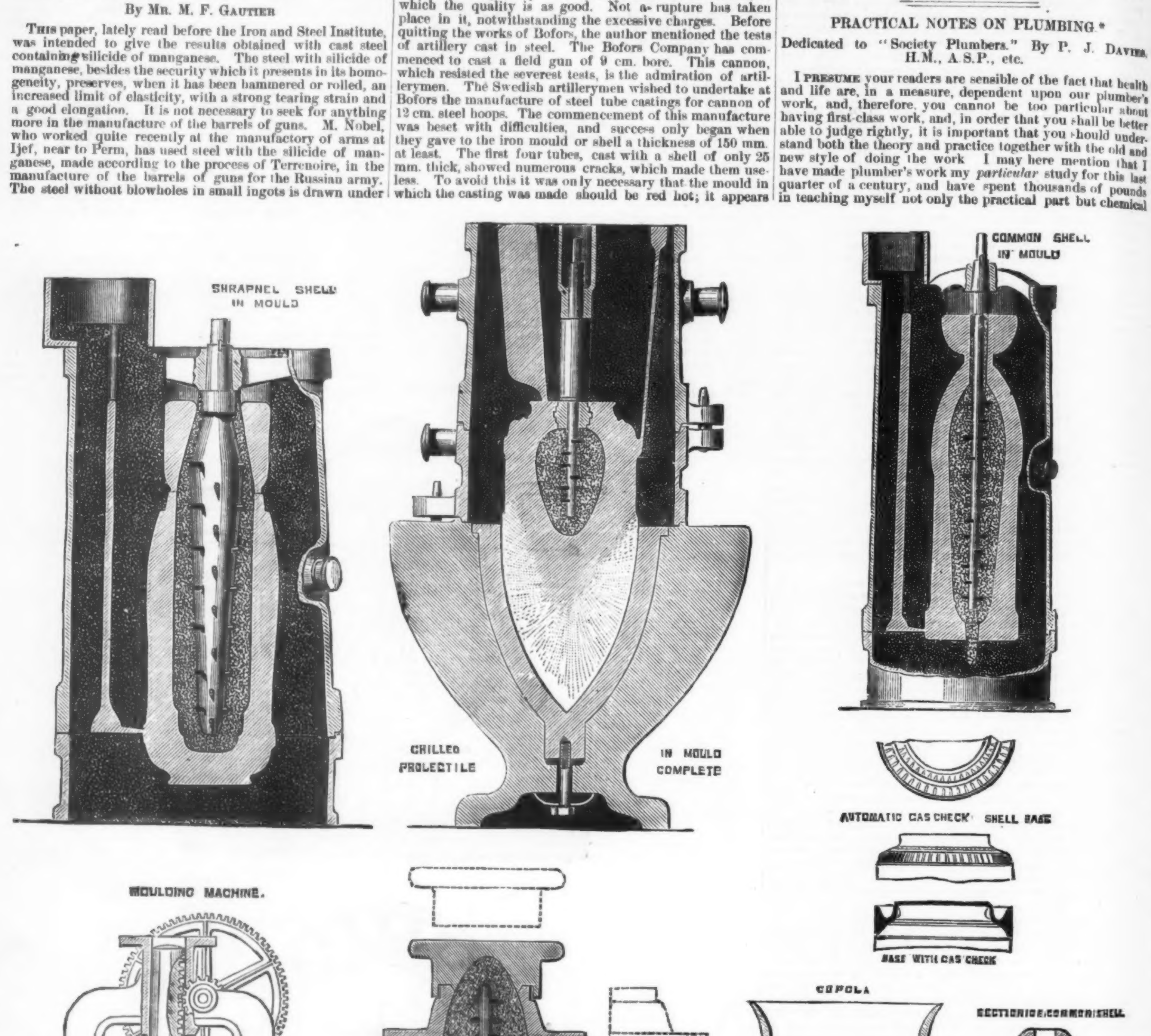
Carbon	0·120
Silicium	0·234
Manganese	0·527
Sulphur	0·020
Phosphorus	0·109

This analysis answers to the best tests, and presented the following resistance to trials:

Diameter of the test 18 *mm.* = 0·7 *in.*

	Kilos.	Lb.
Limit of elasticity	30·13 =	66
Tearing strain	65·50 =	143
Elongation per cent. measure upon 200 mm.	18·7	
Contraction per cent	48·30	
Tearing strain according to the section contracted	128·30 =	282

It was claimed that the tests given proved that the steel of Bofors, applied to the barrels of guns, shows itself superior not only to that of Swedish, Bessemer, or Siemens-Martin manufacture, which has been subjected to experiments, but especially to that manufactured at Witten, of which the quality is as good. Not a rupture has taken place in it, notwithstanding the excessive charges. Before quitting the works of Bofors, the author mentioned the tests of artillery cast in steel. The Bofors Company has commenced to cast a field gun of 9 cm. bore. This cannon, which resisted the severest tests, is the admiration of artillerymen. The Swedish artillerymen wished to undertake at Bofors the manufacture of steel tube castings for cannon of 12 cm. steel hoops. The commencement of this manufacture was beset with difficulties, and success only began when they gave to the iron mould or shell a thickness of 150 mm. at least. The first four tubes, cast with a shell of only 25 mm. thick, showed numerous cracks, which made them useless. To avoid this it was only necessary that the mould in which the casting was made should be red hot; it appears that the rapidity of cooling plays an important part in the physical structure of the metal. In fact, it is not enough that it should be without blowholes; it is also necessary that in the cooling no cracks should be produced. Dealing with the application of metal without blowholes to the manufacture of armor-plates, and of projectiles to pierce them, the author said that the first question is still under consideration. It cannot be said that it is completely solved, yet a great deal has been done, and in France they are now able to obtain cast plates with nearly as much power of resistance as forged steel plates, at a price considerably less. The mixed plate of iron and steel welded together has presented a resistance so superior that the question ought to be studied anew, and they are now proceeding with some trials of mixed plates of iron and steel without blowholes welded together. As to projectiles of cast steel—shells or solid shot—he announced some very decisive results. France and Russia now employ no other material for their naval artillery. These two governments, starting on the principle that in war the straight target will be the exception, and the oblique target the rule, use for their projectiles of penetration the material which gives the best resistance to the oblique target—cast steel without blowholes obtained by the silicide of manganese.—*The Engineer.*



APPARATUS FOR CASTING SHELLS.—WOOLWICH ARSENAL.

PRACTICAL NOTES ON PLUMBING.*

Dedicated to "Society Plumbers." By P. J. DAVIES, H.M., A.S.P., etc.

I PRESUME your readers are sensible of the fact that health and life are, in a measure, dependent upon our plumber's work, and, therefore, you cannot be too particular about having first-class work, and, in order that you shall be better able to judge rightly, it is important that you should understand both the theory and practice together with the old and new style of doing the work. I may here mention that I have made plumber's work my *particular* study for this last quarter of a century, and have spent thousands of pounds in teaching myself not only the practical part but chemical and theoretical work, together with the best methods of doing the same; also in order to obtain the historical parts of the work I spent the greater part of 1876, 1877, and '878 in the Great Seal Patent Office, British Museum, and South Kensington Libraries, etc., gleanings wherefrom I shall place before you in order that you may determine for yourselves whether we are advancing or retrograding.

THE WORKSHOP—IN OLDEN TIMES KNOWN AS "THE PLUMBERY."

The engraving on next page, Fig. 1, shows an old-fashioned plumbery or plumber's shop. Now compare this with the present style of plumber's shop, and say if there are more than half-a-dozen such shops in London? Next. How many plumbers are there in London competent to work the tool or frame shown on the left-hand side of the engraving, and how many more are there that ever saw such a thing? although one of the best tools that ever plumbers worked with. I think I hear you say that we have no use for such nowadays; but we have, as will be explained hereafter, and

* From the London *Building News.*

every *plumber* should know the rudimentary work, if nothing more.

As the old apprentice boy's primitive work was to fire up the pot, it is clear that, by way of a start, he should know something about this. The pot for casting should be large enough to run down at least two tons of lead; it is set like a copper; but care must be taken to set it in such a manner that you can get fire all around the sides and bottom, with a good damper, and at least a 9-in. flue. It is most important a hood should be fixed to convey away all fumes.

"SHEET"-LEAD CASTING.

Fill the pot before lighting the fire; the heat given off from the metal passes among the lead and dries the same. Never put *damp lead* into the fluid metal, or you may find the contents taking wings unto themselves as the lead did from a large pot which was being used for pipelaying when a mischievous boy threw a snowball into it. Now, while the lead is getting hot let us examine the frame previously referred to. *a* 1 is the bed, made with about 2½ in. or 3 in. deals, having a quantity of 3-16 in. holes 3 in. apart, bored into them; the bed is generally about 12 ft. to 15 ft. long, and about 5 ft. to 6 ft. wide, having a fall of 1½ in. to 2 in. in 12 ft from head to foot, *a* 6 to *a* 1 (see engraving). The stand-up sides are the "shafts," which should be kept quite true and smooth, also protected with a sheath when not in use. *a* 4 is the "head-pan," best made of copper, although often made of iron. This head-pan should be made to work on hinges as at *a* 7; *a* 6 is the tipping handle, sometimes pulled up with a crane, other times with an iron bar; *a* 11 is a strip of wood to keep the sand up; *a* 12 the rest-prop for head-pan, *a* 5 the sand-box, *a* 8 the foot-pan In some frames we have a "mid-pan," which is, of course, for short sheets or other castings; but with a very little trouble you can take out one of the bed deals and shift the foot pan to any part you choose. The height of the frame varies from 2 ft. to 2 ft. 6 in., but the lower the better, as you can reach over to plane much more easily

THE COACH.

This is only a kind of oblong pot, shown at W, made to run on wheels; it must be strong enough to carry a ton of lead. Its use is to catch the surplus lead which may run into the foot-pan and to truck it back to the pot.

SAND-BOX.

This is shown at *a* 5. It should be airtight at the bottom, so as to keep the sand as near as possible to the right dampness. V, "the plane," made of copper.

THE STRIKE.

a 2 is the strike; this is rather an important tool, made as follows: Take a piece of dry, solid mahogany about 18 in. longer than the width of the frame, and notch it down, as at Z, to within 1 in. of the bottom of the frame; make the bottom part a little rounded, round the ends for handles, and have some leather muffs made to slip over the ends in such a manner that it will readily take off or on with laces. In order to hold a piece of lead between the handle and muff, hereafter to be explained, you will require a shovel, sieve 1-32 in. mesh, and watering-can with very fine holes.

THE SAND.

As there are many opinions as to the best kind of sand for lead-casting, I will not force my own on the trade, but that of a gentleman more advanced in years and experience than myself, and one who is (as I think) the best lead-caster for the trade. I refer to Mr. Grayham; his advice to me is as follows: "Take common washed sand, which is generally pretty sharp, and mix with a little loam so that it shall bind a very little." During the time I was at my old works at King's Cross, I used the Highgate sand, and found it very handy; but the above gentleman's advice will be useful in any part of the globe.

MAKING UP THE BED.

Having all these things before you, first damp and sift your sand and strew it over the bed at least 1 in. thick; take the strike with the muffs on, and level the sand truly over the bed, the size you require the sheet, but do not make it too wet. If too wet the lead won't run; it splutters and blows; if too dry it won't bind, but breaks up, won't enamel, and the sheet will be rough on the sand side. Experience and practice are the only teachers which will enable you to ascertain the required dampness.

BEATING.

Next take the strike, you at one end and your mate (not laborer) at the other, across the frame; begin at the foot and beat the sand down as firm and even as it is possible until you are at the top; after this, with the strike, skiff the sand, that is by spreading, as it were, the sand smoothly backward and forward. This brings the sand level with shaft.

PLANING.

After the skiffing is over take the plane, V (Fig. 1), and dip it into the pot to make it hot, then rub some touch (candle grease) over the face of same, and thoroughly level and smooth the sand; keep at this until you cannot get smoother, in fact make it shine so that you may see your face in it. Finishing at the foot of the sheet let the sand at the foot finish very sharp, so that the excess lead shall leave the sheet instantly and allow it to contract without pulling away at the surplus lead, otherwise it will crack right across the center of the sheet. The sand and bed being ready, how is the lead? is it getting hot? Place the coach as shown, and wipe all the sand off the strike, next "pack it up" as follows: Suppose you want 7 lb. lead, then place a piece of 5 lb. lead between the muff and the handle (as shown at Z and 9) of the strike; this will leave a thickness for the lead. Remember this: that if you want 7 lb. lead your packing will be 5 lb., if 6 lb. then 4 lb. is required, and so on—in short, always allow 2 lb. lighter lead for packing than you require to get off the frame, unless under special circumstances. The lead is *hot;* bale quickly from the pot into the head-pan. If too hot, it will run too freely and break the sand; if too cool, it won't move. This very much depends upon the lead, if lively or not. It also very much depends on the day, also the state of the sand, and of course the help you receive; experience attained by practice is the main point for success. A cold or windy day is dead against the *work*. A too hot day is as bad, for you cannot keep your strength up; you must have your heat accordingly. The heat is ascertained by the aid of the testing stick, a piece of wood about 18 in. long and 2 in. square or so; put it into the lead and work it about, holding it at an angle as you take it out; if the lead just hangs on the stick it is right. Keep the lead well stirred up from the sides of the head-pan, in order to have uniform heat; if too hot, stir it with some cold plumber's irons (N, Fig. 1). Be careful and have everything ready at the moment; if the sheet is to weigh 5 cwt., then you will want three times this amount of melted lead.

A word or two with regard to the strike; you see it is across the frame, as it now stands; so it should look when the lead is going down the frame. One man at each end presses on the shafts and keeps the strike from twisting by the stiffness of the grip, and must, as it were, fly after the lead, pushing it forward as fast as possible; be sure to keep the strike down and level. Place your strike at the head so that you may take it instantly; well *touch* the edge first.

"THE LEAD'S JUST RIGHT."

"Tip"—it is going down the frame, you after it with the strike, leaving nothing behind but just the required thickness for your sheet; it's in the foot-pan, into the coach, run the coach to the pot, bale back the surplus before set, all's well and all eyes anxiously looking upon the sheet. It being the first, it's a good one; then as quickly as possible rip or trim off the salvages—that is the rough parts off the sides and ends, roll it up and make up your mould for another sheet; remember you have to get off from five to six sheets a day for good work. A crane will be necessary for this amount of work.

If by chance you cannot get the surplus lead away from your sheet just before it contracts, divide the sheet from the surplus mass by drawing a knife across the same.

JOINT-MAKING, BY COPPER BIT, AND BLOWN.

After the apprentice has learned the rudimentary parts of the casting, he should be put to prepare a few joints. The first is the copper-bit joint.

Take two pieces of lead pipe (say 1 in.), and with your saw, "which should be sharp and about 15 in. long, with panel-saw teeth," cut one end true, and with a turn-pin, G, Fig 1, just open, same as shown at D, Fig. 2, then with the shave-hook, Q, Fig. 1, which should be kept sharp by the use of a saw-file, shave all round the inside where you would have the solder unite; next take the inner or male pipe, Fig. 3, true the end, J, then with a 12 in. or 14 in. rasp, middling cut, rasp the end of this pipe to the bevel as shown, then with the shave hook shave the end just sufficiently high to come above the top of the female part, as shown at F E, Fig. 3. Now fix the same firmly as best you can in an upright position, as shown in the cramp, Fig. 3 D, also as shown at Fig. 4. Next see about soldering the same. The first thing required is a "hatchet-bit," L, Fig. 1, Fig. 3 A, also Fig. 3 B, which shows the best shape for general use. This tool is made of copper; therefore you must never exceed a red heat when shaping same. If you do, you are liable to melt it; before you can use this tool there will be something for you to *thoroughly understand*—it is the tinning of same, which is done as follows: Make it just hot enough to melt fine solder (to be hereafter explained), which is a mixture of two parts of block-tin and one part lead. Then rapidly file the end of the tool or iron quite bright and rub this part on a piece of tin called a tin-pan with plenty of rosin and solder mixed together; this will put a face upon it, as it is called: that is to say, that part which you brightened will be tinned over. Next make the iron a little hotter and put some powdered black rosin from the rosin-box, Fig. 4 A, which is made of tin, copper, or zinc, all around the joint, and with the iron melt a little solder all around, taking care not to have the least dirt in your work or rosin. Having melted sufficient solder around your joint, run the nose of your iron well into the solder (hence the reason for having the point of the iron this shape), and well tin your lead, also float the solder round the joint, which is done by drawing your iron (when well hot) steadily round from one side to the other; the joint should be left as smooth as any part of the lead, as shown at E F, Fig. 4, which is done by having sufficient heat in your iron. After all is done, if you have made much mess with the rosin, take some touch and rub over your joint or the dirty part; this, if done when the rosin is hot, will soften same, and you can wipe all away with a small piece of rag.

FIG. 2.

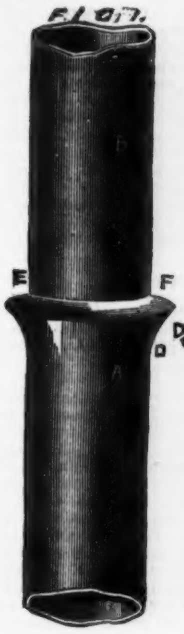


FIG. 3

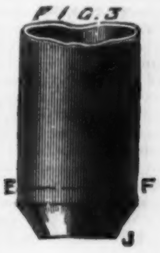
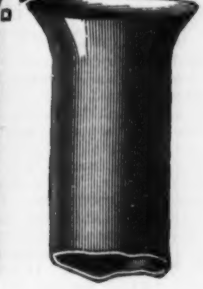


FIG. 4.



BLOWN JOINTS.

A blown joint is made in a similar manner, excepting that in place of an iron you use a blow-pipe and gas or rushes to melt your solder, which can be done with a very little practice. The Fig. 4 B is the general shape of blow-pipe used.

FIG. 4A.

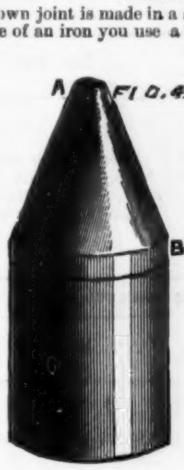


FIG. 4B.

WIPED JOINTS—PREPARATION.

With the apprentice these joints are not quite so easily made as with the copper bit, but with a little practice you will soon get over the difficulty. In the first place, you will prepare the male end as you did for the copper-bit joint, excepting the shaving, but the outside pipe will not be required to be opened quite so wide as before, but as shown in section at K, Fig. 5 (see next page). Here you see that the male and female ends are rasped off. This is in order that you may have a little more solder around the joint without extending the size of same. Now, having all cut and fitted, you will require the ends of the pipes clean from grease or oil. This is done by rubbing a little chalk, whiting, card, wire, or glass paper over same, and well rub it off with an old felt or anything else. Next the soil, smudge or tarnish is a very important thing in wiped joints, especially to the boy.

FIG. 3A.

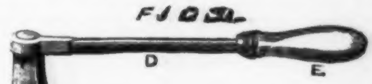


FIG. 3B.

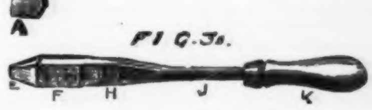
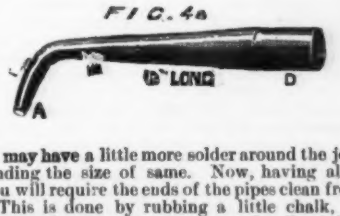


FIG. 4a



THE SOIL AND SOILING

Is very important to the young beginner, but in after life with a little practice he will be able to dispense with it. I was for four years in regular metal-work called "wiping joints," and never used a bit of soil. Mr. Graham, the lead-caster before referred to, has done the same. The soil is made as follows: Take 1 lb. of lamp-black and make it red-hot in your metal-pot, stir it well up and let it cool, then take 2 oz. of pounded chalk and mix well together in water, well grind, with trowel or otherwise, the ingredients together, to the consistency of butter and as fine (a painter's

PRACTICAL NOTES ON PLUMBING.

muller and stone will expedite the operation); make it pretty stiff; lastly, take about ¼ lb. of melted glue—some glue is stronger than other, so that this will vary—stir well together when well hot, and it is fit for use. Thin it to the thickness of cream and use it *cold* as required. The method of testing is as follows: Take the ends of your prepared or cleaned pipes and paint them over with a thin coat and dry it: if it rubs off it has not sufficient glue in it; if it scales up it has too much glue, or has been put on too thickly, or the pipe may be greasy—of course you can burn or blister this soil if too thick. If the solder hangs to it there is too much glue, and will shine, or it is short of chalk. Good soil should work like paint, not rub off, blister, or hold the solder, its effect being to prevent the solder adhering to the pipe not shaved. The soil pot should be made of copper. A small sash-tool half worn out is the best to work the soil with, unless on large work such as cisterns, etc. When putting it on it must be straight, and without daubing your work all over. Cut the edge true, as nothing looks worse than slovenly soiling. Soil your joints from 3 in. to 4 in. past the solder-line.

THE SPLASH-STICK

Is made of wood, about 6 in. long, 1½ in. wide, ½ in. to ¼ in. thick, shaped for holding. Some use iron, but I do not like it, as you are apt to scratch the soil off the lead.

THE CLOTHS.

I do not know any tool more important than a good cloth. It should be made as follows: Take a piece of new moleskin or fustian (the former is the best) of moderate thickness, for ½ in. joint, 12 in. long by 9 in. wide; then fold it up one side 4 in., then 4 in. again, and again 4 in., then fold it in the middle, which will make your cloth 4 in. by 4½ in., and six thicknesses thick. This is suitable for ½ in. or ¾ in. underhand joints. After this is done, sew up the ragged ends to keep it from opening. Then melt a little tallow and pour a little on one side, and the cloth is ready for work. Keep to this side, occasionally rubbing a little touch on this face side. If the cloth is too rough, rub a little chalk upon the face. The use of the tallow is to prevent the solder from sticking to or burning the cloth. It also makes the solder work smoothly.

CLOTHS' TABLE.

This table is for a moderate thickness of material; if very thick, one thickness less. *Underhanded* "to be made as before."

PIPE.	SIZE OF CLOTH.	THICKNESSES.	REMARKS.
Diameter in Inches.	Inches.		
½ to ¾	4 × 4½	6	After 3½ inch use two cloths, the ¾ inch for finishing, and the large one for getting up the heat.
1	4½ × 4½	8	
1¼ and 1½	4½ × 5	8	
2, 2½, and 3	5 × 6	8	
3½, 4, and 4½	6½ × 8	9	
5 and 6	9½ × 10	10	

BRANCH AND UPRIGHT.

PIPE.	SIZE OF CLOTH.	THICKNESSES.	REMARKS.
Diameter in Inches.	Inches.		
½	1¾ × 2½	6	Some prefer a size larger, but the smaller the better, in some cases.
¾	2 × 2¾	6	
1	2½ × 2¾	8	
1½ and 2	2½ × 3½	8 to 10	
2 and 6	3 × 3¾	10	

CISTERN CLOTH.

2½ in. × 3 in. | 8 to 10.

TRAPS AND ODDS AND ENDS.

2½ in. × 2 in. | 6, or the ¾ cloth.

Sew the 5 in. and 6 in. cloths all round, and from corner to corner diagonally. When working 12 in. to 18 in. joints underhanded, larger cloths are required, and are worked two-handed or by *two plumbers*. Before you begin to wipe your joint, stop the ends of the pipes to prevent draught, which will make a very great difference when you are at work with the metal.

SHAVING.

Sharpening the shave-hook has been before referred to. Some plumbers throw this tool about as at Q, Fig. 1, or into their bag with hammers, chisels, files, etc. I wish to impress upon the young plumber's mind the necessity of keeping it free from notches by proper protection and care. Shaving may be learnt in a few days. You should practice on a piece of pipe to see how round and true you can shave it; shave it clean and even, not too deep, round the edge, see E F, Fig. 6. Having all your work prepared, fix the joint together, as at section, Fig. 5, which is a round joint to be made either upright or underhanded. You see at K that the male fits, but a little recess is left for the solder to get into. Many plumbers close this; they cannot do a worse thing, as it is very useful in joint-making. At Figs. 7 and 8, you see a full-sized 1 in. joint; this is how the joints should appear when finished; Fig. 7 is a short, and Fig. 8 a long joint. On examining the full-sized section, Fig. 5, you will notice the dotted lines, H I, show the outer line of the solder on the long joint, and F N, the outer line of the small joint. The small joint does not take the amount of solder of the large joint, and on further examining same across the center of joint at D, you will perceive an equal thickness of solder, therefore the joints are equally strong across the actual joint. There is one advantage with the long joint—it is easier to make, because you have a larger quantity of solder to play with, which retains the heat, and also a larger cloth; its length also renders it less liable to show imperfections as to roundness, etc. The large joint should be first practiced upon, and then try to reduce same, keeping in mind that the center thickness of solder is the principal point to watch. This substance of solder is generally about twice the substance of the lead at that point, not merely for strength, but for other purposes to be explained. Every plumber should know that solder is much stronger than lead, taking it bulk for bulk; still this thickness cannot be made the rule, inasmuch as some waters are chalybeate or impregnated with iron, etc., which readily attack the metals composing the solder; in such cases you must use discretion as to the substance of metal around your joint.

COLLARS.

Suppose you have your joint upright, as at Fig. 9, you will require something to catch your metal (solder); then, if you have a piece of sheet-lead handy, cut a collar, which is generally made by cutting it round or otherwise with a hole in the center the size of the pipe; if too large, pack some newspaper between the collar and pipe. Well soil same and tie a piece of string round your pipe, as at A, Fig. 9, which will support the collar and prevent the solder running through; to support the outside part of the collar, tie your compasses as shown at M N, and the ends of the compasses will act as props, but if no compasses to hand two pieces of stick tied across the pipe, or an iron chisel or screw-driver driven into the wall, etc., will answer. The collar should be put on as shown at F G, as level as possible, as it is much better for parting your solder round the bottom. When fixed as at D E, the solder drops down and sets round the bottom, and is at times very difficult to remove without the iron, as it cools much quicker when in a small body.

Before you begin to wipe your joint stop the ends of your pipes to prevent draughts. "The metal's hot—bung it!" is the cry. During this time you should select your cloth. In this case, for a 1 in. upright joint, the size is 2½ in. by 2¾ in. The metal's here: you give your cloth to the mate, who will get the face side warm by holding it over the metal-pot (or, if you can trust him, he will get your cloth for you and bring it ready warm). Take a felt, that is a piece of old carpet, 9 in. long or so, to hold your ladle with, then take your ladle full of solder and set to splashing your metal on the joint with the splash-stick as shown at H, I, J, K, L, Fig. 9, taking care not to burn the pipe with the solder, that is, by splashing too much in one place; look sharp and get up your heat by getting on as much solder as you want, and as near the shape as possible. Keep it alive by working it up with the splash-stick. If it drops down push it up again with the stick, warm it up with fresh metal, keep at it until you have the joint to look as at I, J, K, L; now take another ladle of hot metal and splash it up the soiling about and round B. To get a little more heat on your lead, keep splashing and patting it up to the proper shape with your splash-stick. It is just hot enough; now take your cloth, well hot on the face side, in the left hand, and with a sharp sweep wipe quickly and clean round the top and back part of the left-hand side of your joint, then the bottom, next the center, change hands and do the other side, that is, round I K, and finish by wiping down from B to H, and from H to K L, and your joint is done. While hot, part your metal so that it will leave the pipe. You do not require an iron for this; keep practicing at this until you can do it without. Pray don't use irons if you can do it without: you will do better hereafter. The time required to make this joint is about one and a half minutes, that is getting up your heat and wiping included. The wiping alone should not exceed twenty seconds.

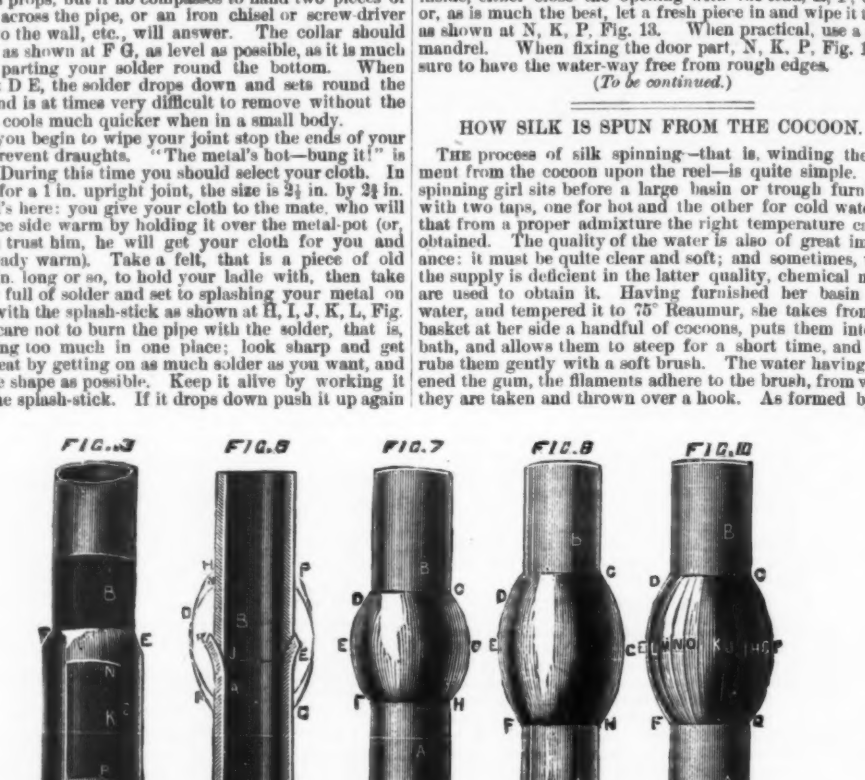
OVERCASTING.

Before we leave this kind of joint-making, let me say that in London you will not require to overcast your joints, as was the custom in the time of the old architect Vitruvius, one hundred years before Christ, but when in the country you may, that is to say, when your solder has to be used very coarse. This is done as follows: Suppose your solder to be four of lead and one of tin, the solder would set quickly and be very porous; then you will want an iron to warm or liven up your solder. The same iron will do your overcasting, as follows: Having shaped your joint, well touch the same; take the handle part of the ball of the iron and rub it from bottom to top of the joint, just to glaze the joint, then bring it down again the same way; this gives the glazed or ribbed line, which should not exceed half an inch wide, G, Fig. 10. Next do H, taking care to let the outer line cut the glaze of G; next do I J; begin at the other side and bring round as at L, M, N, O, and finish at K, or if you want it to look even all round, begin at one place and go all round until you come to where you began, keeping an eye to your ribbed lines.

INTERNAL "JOINT-WIPING."

In some cases when upright or underhanded joints, it will be found impracticable to wipe round the back of the pipe; for instance, suppose you want to wipe a 4 in. joint round a pipe which was lying within half an inch of a ceiling or wall, it would be impossible for you to get your hand round. In this case, prepare your joint as at Figs. 11 and 12, so that you may wipe half from the inside as at S, Fig. 12, which is done by cutting the pipe in front and opening same; of course you must wipe your solder flush with the pipe; H I shows the soiling, and E, F, G, D, the lead laid open, P P the center of the joint or lead; having wiped the inside, either close the opening with the lead, E, F, G, D, or, as is much the best, let a fresh piece in and wipe it there, as shown at N, K, P, Fig. 13. When practical, use a short mandrel. When fixing the door part, N, K, P, Fig. 13, be sure to have the water-way free from rough edges.

(To be continued.)



PRACTICAL NOTES ON PLUMBING.

HOW SILK IS SPUN FROM THE COCOON.

THE process of silk spinning—that is, winding the filament from the cocoon upon the reel—is quite simple. The spinning girl sits before a large basin or trough furnished with two taps, one for hot and the other for cold water, so that from a proper admixture the right temperature can be obtained. The quality of the water is also of great importance: it must be quite clear and soft; and sometimes, when the supply is deficient in the latter quality, chemical means are used to obtain it. Having furnished her basin with water, and tempered it to 75° Reaumur, she takes from the basket at her side a handful of cocoons, puts them into the bath, and allows them to steep for a short time, and then rubs them gently with a soft brush. The water having softened the gum, the filaments adhere to the brush, from which they are taken and thrown over a hook. As formed by the worm, the filaments are too fine for textile purposes, therefore a number of them are united into one thread. This number varies from four to seven, according to the thickness required. Taking the necessary quantity from those on the hook, the girl roughly twists them into one thread, and introduces it into a small hole in a little disk composed of porcelain, and fixed upon the opposite edge of the trough or basin. A vertical iron rod rises close to the disk, and at about three inches above it carries a small wheel with glass spokes, and a second wheel of the same kind six inches above the first. A horizontal bar receives the ends of the vertical rods, and for each of the latter contains a hook of porcelain. Glass and porcelain, or other hard materials capable of receiving a fine polish, are used for the passage of the silk, because they do not readily wear into grooves nor rough by oxidization, and so injure the thread or become useless, while they preserve or increase its luster.

The thread formed from the combined filaments is carried from the disk to the upper wheel, and back thence to the lower one, by which means the filaments kept together by the disk are formed into a round thread by the revolution of the wheels caused by the passage of the silk over them. Around the length of the thread extending between the wheels the spinner twists the end in her hand, in order to prevent the passage of knots, loose fiber, and down; for the filaments are covered with a microscopic down almost like that on a peach. After this it passes upon the reel or asp, on which it is traversed in layers over a space of two or three inches, in order that the revolutions of the reel may thoroughly dry the silk and harden the gum, without which the threads would be apt to stick together and prove defective in subsequent operations. This traversing is almost like the "cross-reeling" of yarn in the cotton trade, by which the thread is made in every revolution to cross the preceding layer, enabling the end when wanted in succeeding operations, or after a breakage, to be easily found. When the required quantity has been reeled upon the asp, the latter is made to collapse, and the skeins or kusts are easily removed.

Every dealer in silk goods knows to his annoyance that

the woven silken fabric is often "stripy" in appearance, showing thick and thin bars, which when seen in a particular light, especially in colored goods, strike one as great defects, and deteriorate the value considerably. These bars are serious faults, and the cloth in which they appear is not as good as that which is free from them, or nearly so, it probably being impossible to eliminate them altogether. The foundation of the defect lies in the silk filament as made by the worm. When it commences to spin it is filled to repletion with the silky secretion, which causes the filaments at the commencement of the exudation to be thicker than later on. The threads as the "spinning" proceeds gradually become attenuated as their fountains approach exhaustion. Before the worms have finished, the filaments have become so fine that a portion becomes unusable. This irregularity can to a great extent be limited in the filature or spinning mill, the operations of which we have just described, but nowhere else. In commencing reeling from the cocoon, the operative takes the number of filaments required to form a thread of the thickness needed. This number may be, say five. As the spinning proceeds the thread formed from the united filaments becomes perceptibly finer, and to correct this a sixth filament should be added; further on a seventh, and in some cases even an eighth is required. Careful attention to this point constitutes a good reeler; neglect of it a bad one. The silk thus reeled is good or bad as may have been the attention. It will be quite obvious that extraordinary sharpness of sight, intelligence, and honest labor will be required to produce the best results. As these qualities cannot often be found in Italy any more than in this country—though the reelers of Italy are the best in the world—it need not be surprising that silk fabrics often prove defective and "stripy." These faults would, however, be more serious and frequent if other means were not taken to prevent them, which will be explained subsequently.

The silk in the condition as it leaves the reeler is called raw silk, and is made up into large hanks of no specified length, which are termed knots, each bunch of which is called a moss, and each bundle a book.

The silk filament yielded by each cocoon is from three to six hundred yards in length, the remainder being either too flossy, fine, or entangled to be wound; it is added to the "waste." Of the weight of cocoons given out to the reelers, on an average one fifth is returned as net silk in the hank. We have spoken of waste, but nothing is lost in a "filanda." The loose, short stuff, or broken ends, are carefully gathered together; so also are the finer portions of the filaments forming the bottom of the cocoons, which are cleansed from the dead chrysalides or particles thereof, and together with the former are exposed to the sun to dry. This stuff is called "struse," and after packing, if of good quality, is sold, fetching from six to eight shillings per pound.

We have described how one thread is spun from a number of cocoons. In each case this is duplicated, and sometimes there are even three sent over the asp at the same time. Thus each spinner has to watch 12 or 18 cocoons, and, with the vivacity which is characteristic of the Italian female sex, oftens displays the most lively interest in their behavior, endowing them with a personality, coaxing them to run off without breaking, or abusing them roundly when they leap from the bath or entangle and break.

The silk is now spun. Twice a day, at twelve and eight o'clock, the women carry the product of their labor to the silk room in the form of the large hanks as doffed from the reels. These are placed upon the numbered pegs, the number corresponding to those of the reeler, each having one. In this room their work is subjected to careful examination, to see that they have done their duty. Owing to the fineness of the thread of silk, which is the average of the five or six cocoon filaments, it requires a very experienced eye and the nicest sense of touch to detect irregularities in the thickness, and neither sense nor both combined are pefectly reliable or trustworthy. Weighing is therefore resorted to, and, as required by the article, the most delicate weight is used—the "denier," which is the equivalent of a grain of corn, and on the decimal system equals half a decigramme, a weight which in the hand is quite imperceptible.

The average weight of a filament of a silk, as reeled from the cocoon, and which in length is usually 400 "aunes," or ells, 2½ to 3½ deniers, according to the quantity of the cocoon; therefore a thread of silk composed of four, five, or six cocoons, will be four, five, or six times that weight. The examiner, generally a girl, stretching the hank upon four pegs, fitted into the arms of a wooden cross, proceeds to wind 400 ells from the mass upon a small hand reel, which by the stroke of a bell indicates every 100 revolutions, each revolution measuring one aune. Turning the reel with one hand, with the other she holds the passing thread, her experienced touch enabling her to detect every important variation of the thickness. At the same time her eye is engaged in watching the thread gathering upon the reel, to ascertain whether an insufficient twist in the reeling process has allowed the down or other impurities to pass. The thread will sometimes break, but should it often do so, it is a proof that the cocoons were reeled from tepid water—too cold for the purpose. All these tested lengths or "proofs," as they are called, are numbered and suspended on a board to await the final examination of the manager, each having appended to it the remarks of the examiner. The manager next carefully weighs these on a delicate balance, and if the weight is under or over the required number of deniers, the thread is thus proved to have been irregularly reeled, and the reeler to have displayed a lack of care in her work. To obtain uniformity the knots are carefully sorted according to their "proofs," trimmed, and then folded, by being skillfully twisted into the form of a rope, and packed into bundles ready for sale, and in that condition is commercially known as raw silk. It is this sorting which is principally relied upon to prevent the "stripy" appearance in the woven fabric referred to previously. Like most other articles, silk is sold by its quality, and this is usually indicated by the weight of the proofs, the finer qualities having usually a finer thread. They range therefore from 9-11 deniers to 400 ells to as high as 40-45. Two or three threads are worked together occasionally, and when this is the case, the number of deniers per 400 aunes increase proportionately.—*Textile Manufacturer.*

CORROSION OF PLATINUM.—The carbonaceous deposit formed on platinum after exposure for some time to an oxidation flame, contains an amount of platinum so small that it is generally neglected, when wiping the base of a crucible blackened in the flame before weighing. On calcining 0·022 grm. of a carbonaceous deposit formed on a platinum capsule on exposure for half an hour to a red heat in the upper part of a Bunsen flame, the author obtained 0·01 grm. of the metal. Further experiments showed that the corrosion of the platinum is due not to carbon in suspension, but to one or more of the gaseous elements of the flame.—*A. Rémont.*

SHIPBUILDING A THOUSAND YEARS AGO.

MR. COLIN ARCHER read an interesting paper on this subject at the recent meeting of the Institution of Naval Architects, as also at the York meeting of the British Association.

It is a well-known historical fact that as far back as the early part of the Middle Ages, the inhabitants of Scandinavia were a great seafaring nation. In many of the great battles fought between the chiefs and pretenders of that period—and they were not few—we find several hundreds of large war ships ranged against each other. It seems to have been quite a common practice for the young chiefs, in order to relieve the monotony of life on shore, or to escape the consequences of some lawless act, to equip one or more ships, manned by their retainers, and to launch forth in quest of adventure, plunder, or "the bubble reputation." And these excursions were not always confined to home waters; they were frequently extended not only to the coast countries of the north of Europe, but also to the shores of the Mediterranean. Iceland was discovered about the middle of the ninth century by Norwegian adventurers, and there are good grounds for believing that an expedition starting from Iceland landed and established a colony in the present New England States nearly 500 years before Columbus lived.

But the descriptions which the old Sagas afford of the vessels in which these expeditions were undertaken and these battles were fought are very meager. It was therefore looked upon as an event of great interest when, on excavating a large grave-mound near the entrance to Christiania Fjord, a ship, evidently from the Viking period, was discovered in a wonderful state of preservation. There is reason to believe that this ship, although comparatively small, does not differ materially in her manner of construction or in shape from the more powerful war ships, or from those used for long voyages. She is probably a true model of the ships which carried Rollo and his brave followers to the coast of Normandy; and it may therefore be assumed that a brief description of her, as she now appears from a shipbuilder's point of view, may not be without interest.

It was not to be expected that a delicate structure such as this Viking ship could remain for eight or ten centuries buried many yards under ground without sustaining some damage, or that she should perfectly retain her original form. It is rather a matter of surprise that the damage is so small as it is. Thanks to careful handling and a judicious arrangement of supports, there is reason to believe that, apart from local strains and contortions of form, the hull as it now stands represents very closely the ship as she appeared when put into the ground. Mr. Archer has taken off her lines with as much accuracy as circumstances would permit, and, referring to these lines, he explains the chief peculiarities of the construction.

The principal dimensions are:

	Feet.	Inches.
Length, between the rabbets at gunwale	77	11
Breadth, extreme	16	7
Depth from top of keel to gunwale amidships	5	9

The vessel is clinker built, and the material all oak. There are sixteen strakes of outside planking, the ordinary thickness 1 inch, average breadth amidships 9¼ inches, including 1 inch land. The lengths vary from 8 to 24 feet. The scantling is not, however, uniform throughout; thus the tenth plank from the keel is about 8 inches broad and 1¾ inches thick, and forms a shelf for the beam-ends. The fourteenth plank from the keel, or third from the top, is about 10 inches broad and 1¼ inches thick. This plank, which we may call the "main-wale," is perforated with holes for the oars, sixteen on each side, about 4 inches diameter, and provided with a slit at the after and upper edge to allow the blades of the oars to be passed through from inboard. The two upper strakes are the thinnest of all, being scarcely more than ¾ inch. The gunwale, 3 inches by 4¼ inches, is placed in the usual manner inside the top strake. The boards are throughout united to each other by iron rivets about the thickness of an ordinary 3 inch spike, spaced from 6 to 8 inches, with large flat heads 1 inch diameter. The riveting plates are square or nearly so, ¾ inch. The nails are driven from the outside, except near the ends, where riveting inside would have been difficult from the sharpness of the vessel. The nails are here driven from the inside and riveted outside. The garboard strake is fastened to the keel with rivets of the same kind as those used for joining the strakes with each other.

The keel is of a peculiar shape; it is about 14 inches deep, of which 11 inches are below the rabbet, 4¼ inches thick at the lower edge, and only 3 inches at the rabbet. The top of the keel is 7 inches broad, thus affording a large surface for the garboard strake, besides combining strength with lightness. Possibly also the increased thickness of the lower edge may have been adopted to improve weatherliness under sail. It is difficult to say where the keel ends and the stem and sternpost begin, as these run into each other with a very gentle sweep; but the piece of wood which may be called the keel proper is 57 feet long; to it are joined a short forefoot and heel piece by short vertical scarfs secured by double rows of rivets. These pieces again are fitted in a similar manner to the stem and sternpost. The posts are sided 8 inches, chamfered to 2 inches outside edge. They are 15¼ inches broad outside the rabbet just above the scarf, decreasing in breadth upwards.

The framing of the bottom consists of grown floors extended in one piece from shelf to shelf. The average spacing in the body of the vessel is about 3 feet 3 inches from center to center, greater at the ends: there are nineteen frames in all. The floors are neatly finished, of a shape which combines strength with lightness and elasticity. The lower surface has a flat projection in which are holes for receiving the fastening for the plank. The way these fastenings are managed is very peculiar. The planks are evidently worked down from stout slabs, and in doing so a ledge an inch high has been left on the inner surface running along the middle of the plank. The floors are not fayed down on the boards; they have only two points of contact with them, the upper edges and the ledge above mentioned, in which are two holes bored transversely, one on each side of the timber. Through these holes and corresponding holes in a fore and aft direction through the timbers are passed ties made of the tough roots of trees. These ties are very slight, scarcely ¼ inch diameter; they are crossed over the ledge on the board, only passing once through each hole. The ledge has been removed in the spaces between the timbers, so that the remaining parts under the timbers look like cleats fastened to the plank. With the exception of a nail driven through the "shelf" and riveted on the extreme end of the floors, these ties seem to be the only fastenings used at this part of the vessel. The floors are only about 4 inches diameter, a foot from the garboards, and taper, siding as well as moulding, down to 3 inches or even less at the shelf. They are not fastened to the keel.

As already stated, the beams, which are sided 7 inches, moulded 4 inches, rest on what Mr. Archer has called the "shelves," which however only differ from the ordinary planking by being ¾ inch thicker, and of greater lengths, the longest piece being about 48 feet. The beam-ends also rest on the ends of the floor timbers. They are secured by knees extending down the ship's side from the upper edge of the "main-wale" with an arm on the beam. These knees are fitted close to the planking at the side, and fastened with oak trenails. Being a little narrower than the beams, a ledge is formed on each side for the bottom boards or flooring, which is made to fit into these ledges from beam to beam, thus forming a continuous platform. A strip of wood is nailed on top of the beams in continuation of the knees where these are too short to welt from opposite sides. The beams are supported amidships by pillars resting on the throats of the floors. The top sides, consisting of the two thin boards already mentioned, are connected with the body of the ship by independent timbers intervening between the knees, and extending from the under side of the gunwale some distance down the side, but not so far as the platform. There are no timbers in the upper part of the vessel, overlapping or making a shift with the floors.*

It will be seen that by this system of construction the upper portion of the ship is altogether unconnected with the bottom part, so far as framing is concerned, an arrangement which would scarcely be safe where much ballast or a heavy cargo is carried on the ship's bottom. No doubt heavy weights when carried were placed above the platform, in which case there would not be the same tendency for the two sections to part company.

Perhaps the most singular part of this singular ship is the arrangement for stepping and supporting the mast. The step is a solid log of oak 11 feet long and 19 inches broad by 14 inches deep at the middle, tapering to the ends. It is countersunk over the throats of the floors, to which it is fastened by means of small knees on either side. From this trunk a branch grows out vertically in front of the mast and quite close to it. This branch, which is nearly 12 inches thick, is fastened to what Mr. Archer has called the "fish."

The fish is a ponderous piece of oak lying along the middle line of the vessel, on top of the beams, and extending over five spaces. It is 16 feet long, 38 inches broad, and 14 inches deep at the middle.

This block is modeled so as to represent the tails of two fishes or whales resting on a flat slab or sole piece about 4 inches thick. The slab is countersunk over the beams and well secured to them by knees. A large slice is taken off the back of the fish, the upper surface thus forming two planes inclining to either end. The extreme ends of the tails are only about 3 inches thick above the slab. A slot 5 feet 9 inches long and 12¼ inches wide (the diameter of the mast) is cut in the fish from a point a little in front of the middle toward the stern. The mast is stepped through the forward end of this slot, and when erect kept in its place by a heavy slab fitted into the slot. In the end view this slab is shown with the after end raised level with the forward end. By removing the slab and slacking off the fore-stay the mast would be free to fall aft in the slot, and could thus easily be lowered. In order that the beam nearest the mast should not interfere with this maneuver there is a depression in it which enables the mast to fall back the whole length of the slot.† There is a stanchion about 8 feet high, with a cross-beam at top in which are semicircular depressions for the spars to rest in when not in use. There have been three such stanchions.

The mast, which is 12¼ inches diameter, has been cut about 10 feet from the foot. The extreme top of one of the spars found in the ship, corresponding in size to the part which remains, has rotted away; but if this spar, as seems probable, is the upper portion of the mast, the whole length may have been 40 feet. There is another spar which looks as if it might have been the yard. It is broken off near the middle, but Mr. Archer estimates its full length at 35 feet, diameter at slings 8¼ inches, at arms 3½ inches. Abreast of the forward end of the fish, strong pieces of wood, one on either side, each with two circular sockets, are fitted down between the timbers just above the platform. Possibly one of these sockets may have served as a step for a squaresail boom. The other may have received a pair of shears to give elevation to the fore stay when raising or lowering the mast.

With regard to the rudder, a conical piece of wood sufficiently long to keep the rudder clear of the ship's side is fitted with its base to the outside planking; through a hole bored through the center of the cone, and a corresponding hole in the rudder, a stout rope is rove, provided with a knot at the outer end and made fast inboard. This rope acts as a pivot, allowing the rudder to be twisted by means of the tiller fitted athwartships. An iron staple near the lower extremity of the rudder, and a small ring bolt at the upper end, may have been fitted with guys leading aft to steady the rudder and keep it immersed when the ship was under way. The rudder-head or stem is round, 6 inches diameter. At the pivot it is 7 inches thick, thence decreasing in thickness downward. The breadth is 15 inches at pivot, increasing to 22 inches at foot. Both edges are beveled off, particularly the front one, which is reduced nearly to a feather edge. The rudder is all of one piece of wood.

The extreme ends of the vessel are unfortunately gone, so that it is not easy to see how she has been finished off here. The lower planking takes a very decided turn upward as it approaches the ends, running in fact almost parallel with the posts. If therefore all the wood ends have joined the posts, these must have been very high. It seems not improbable that part of the planking has been received into a rabbet in the gunwale, or in a breast-hook connecting the gunwale with the stem or sternpost. This, however, is merely a conjecture.

If the old ship can be looked upon as a fair sample of the ships of her time, it is evident that shipbuilding a thousand years ago was something very different from what we now understand by that term. What strikes one most forcibly on seeing this vessel as she now stands is the extreme lightness of her scantling and the total absence of anything in the shape of lining, longitudinal stringers, or similar con-

---

* This mode of binding the two sides together by means of beams halfway between gunwale and keel is still practiced in the west and north of Norway. Even small skiffs are tied together in this way, loose thwarts being placed over the beams, only resting in a notch cut in the knees, which secure the beams, while the floor-timbers merely butt up against the beams.

† In the Scandinavian languages the technical term for the framing which now takes the place of this colossal structure in our modern ships—the mast partners—is still *Fisken*, the fish.

trivances for giving what we should consider the strength and rigidity necessary in a sea-going vessel. It would, however, be unfair to compare her with a ship of modern build of the same size. Even the designation "ship," as applied to her, is apt to convey a false idea. She is in fact a very large sailing rowing-boat.

These ancient vessels may be considered as consisting of two distinct sections, each having its special use and function. The portion above the beams is the hold proper, the useful space. Here the crew had their abode, and here was carried probably all that the vessel had to carry, and this portion is comparatively strong. The material is no doubt here also of small dimensions, but what there is has been judiciously distributed, is of good quality, and has been well put together. It should also be remembered that the weight carried was small in quantity as compared to the carrying capacity, and consisted principally of live cargo, and this kind of loading is much less trying to a vessel in a seaway than a similar loading of dead weight would be. The lower portion of the ship, on the other hand, had a different kind of duty to perform. It had to supply the "form" necessary for small resistance and rapid locomotion, and to float the upper section; keeping this in mind it will be found that her construction gives evidence of a great deal of practical skill and ingenuity. Every part of the vessel is sufficiently strong for the duty expected of her, while at the same time economy of weight of material has been studied throughout. It will be seen that the weight of the superstructure is taken entirely by the floor timbers, the ends of the beams resting on them, while the beams are supported amidships by the props stepped in the throats of the floors. There would therefore be very little stress on the ties of the bottom planking, which latter, there being no counteracting pressure on it from the inside, would always tend to cling to the timbers by the pressure of the water outside. The only weight of any moment which would tend to separate the two sections of the boat is the mast, and this tendency is met by the "branch" of the step being secured to the "fish." Still there can be no doubt that this boat possessed a pliancy and mobility in a heavy sea which we should look upon as ominous in a modern sea-going craft. Her real safety consisted in a tough and elastic outer skin, which would be more invulnerable from not being made unduly rigid at any point. Thus her apparent weakness was her real strength. Mr. Archer has not been able to discover anything deserving the name of a bolt in the whole structure. The stoutest iron fastenings are the rivets in the scarfs of the keel and the nails securing the inside knees, and they are no stronger than ordinary four inch spikes.

It seems probable that such a boat would be capable of great speed, even under oars alone; with a fair wind she must have been very fast. Mr. Archer has assumed a low water-line, and finds that at this trim her displacement is 994 cubic feet, or 28·4 tons; area of immersed midship section, 24 square feet; extreme length on load-line, 73 feet 3 inches; and draught of water, 3 feet 8 inches. Allowing 10 tons for her complement of 100 men with their accouterments, leaves 184 tons for the vessel, with inventory, stores, and equipment, and this allowance is probably ample. The areas of cross-sections are obtained by multiplying the ordinates of the curves by 4 feet.

MAN AND WOMAN—AN ANTHROPOLOGICAL COMPARISON OF THE TWO SEXES.

By G. Delaunay.

The sentimental pretensions of a political school which professes that woman is intellectually the equal of man give a character of actuality to the question of the comparison of the two sexes. This question, which is ordinarily treated from a metaphysical point of view, is, for us, purely an anthropological, or rather a zoological one, for we shall show by very characteristic examples, taken from the entire range of the animal kingdom, that sexuality under goes the same evolution in all species, including the human species.

Species.—The female is superior to the male in certain of the lower species. The males are much the smaller in a great number of cephalopods, in certain cirripeds. With some exceptions, the superiority of the females exists in almost all the annulates—bees, hornets, and wasps, the females are much more highly endowed than the males. In butterflies, the females are, for the most part, larger and heavier than the males, a difference which is observed even in the larvæ. The same superiority of the females is found in many of the fish, and in particular in the cyprinoids. Reptiles present the same character of inferiority on the part of the males.

But the case is not the same with the higher vertebrates. Indeed, in birds and mammals, the male excels the female.

Summing up, the two sexes, at first unequal on account of the superiority of the female over the male which characterizes the lowest species, become equal in certain species somewhat higher in the animal scale, and again become unequal in consequence of the superiority of the male over the female which is observed in all of the higher species. The superiority of the female is then the first term of the evolution experienced by sexuality, while the superiority of the male is the last term.

Let us now see in what the superiority of the male consists. In birds and mammals, including the human species, the nutritive phenomena are more strongly marked in the male than in the female. The blood is thicker, redder, and contains more red globules and hemoglobin (Quinquand, Korniloff), less white globules and water. M. Mallassez found in the man a million more red globules per cubic millimeter of blood than in the woman.

The man eats more than the woman. The departments of charity know that a boy costs more to feed than a girl. Yet the woman, although she eats less, is greedier (Brillat Savarin) and eats more frequently, being oftener urged by hunger. Our city women are continually eating, like our children. In our asylums for the aged, the women, who should not eat oftener than the men take away from each of their meals a certain quantity of food, which they consume in the interval, so that they double the number of their meals.

The respiratory phenomena are likewise more intense in the man than in the woman. For the same height the pulmonary capacity is less by a demi-liter in the woman. The thoracic index of the woman is inferior to that of the man (Weisgerber). The man absorbs more oxygen, although he breathes less frequently. According to Quetelet, from 15 to 50 years of age, the woman has one respiration per minute more than the man. The man at every age excretes more carbonic acid than the woman (Andral and Gavarret). According to Scharling, the quantity of carbon excreted per kilogramme and per hour is about 0·22 gr. in a girl of ten years, and about 0·25 gr. in a boy of nine years. So also the quantity of urea contained in the urine is, in the man, about 28·8 grammes per 1,000 grammes, and in the woman about 19·1.

The temperature is higher in the man than in the woman, just as it is higher in the cock than in the hen, etc.

In regard to circulation, the blood pressure is greater in the male than in the female, but the pulse is less frequent. The difference is about 18 pulsations per minute in the lion, 10 in the bull, 12 in the ram, from 10 to 14 in the man.

The anatomical superiority of the male over the female occurs everywhere from the standpoint of animal life. "In males," says Wundt, "the organs which preside over the animal functions are normally more developed."

The skeleton of the woman is lighter in reference to the total weight of the body. "The woman, by all the physical characteristics of her skeleton, is intermediate between the child and the adult male" (Topinard). Mr. A. Milne Edwards has found that the bones of the male are a little richer in inorganic matter than those of the female, and that at the age of 30 the bones of the man contain more mineral matter, less organic matter, more carbonate of lime, less phosphate of lime, than those of the female.

The woman is less right-handed than the man. The preeminence of the right side over the left is less in the woman

SUGGESTIONS IN DECORATIVE ART.—MONUMENT BY R. DIETELBACH, SCULPTOR, STUTTGART.—*From The Workshop.*

Harting). According to M. Livon, the left scapula is larger than the right, as in the lower races. Broca has found that the length of the clavicle in reference to the shoulder is greater in the woman than in the man, as it is also greater in negroes than in Europeans.

From an exterior point of view, the man is always larger than the woman. This is observed in our domestic animals. The greyhound and spaniel are always larger than their females. According to M. Topinard, the man should average 12 centimeters more than the woman. The woman is also less heavy than the man, although she often appears larger by reason of the adipose system, which is greater in her than in the man. Indeed, in the wandering fairs the women are renowned for their stoutness, the men for their height.

"In all our Indo-European series, the woman is more prognathous than the man."

According to my researches the woman has a flatter and less arched foot than the man, which is a sign of inferiority. The high heels which support our fashionable ladies are made to conceal this flatness and length of foot.

From the standpoint of sound, the voice of the female is always more shrill than that of the male. The hen, the bitch, the mare, have a higher voice than the cock, the dog, and the horse. The tone of the she-ass, from the observation of Buffon, is clearer and more piercing than that of the ass. In the same way, the voice is sharper in the woman, who always sings an octave above the man.

Let us now consider the muscles, the skull, and the brain. The male has the muscular system more highly developed and is more vigorous than the female. This is observed both in wild and in domestic animals. The muscular force, measured with the dynamometer, in a woman of twenty-five, is a third below that of a man of the same age. The movements of the man are more precise than those of the woman. Among the pianists of both sexes, execution attains a higher degree of perfection with men.

The cranium is more capacious in the male than in the female. (Soemmering, Parchappe, Broca, Morselli.) Huschke estimates for Europeans the average capacity of the cranium at 1,446 cubic centimeters in the man, and 1,226 in the woman—a difference of 220 centimeters in favor of the man. Dr. Weisbach, according to his measurements of German crania, finds that the female are to the male as 878 to 1,000. Morselli also found that the cranium of the man being 100, that of the female was 85. According to Broca, the difference in cranial capacity in favor of the man is about 150 cubic centimeters for the French in general and about 221 for Parisians.

The form of the skull also varies with the sex. "In the woman, the skull is, as a whole, less high and more elongated" (Broca).

The brain of the male is heavier than that of the female. Let us take the gorilla for an example. The brain weighs 530 grammes in the male and 470 in the female. According to Broca, the average weight of the brain is about 1,323 grammes in the man and 1,210 in the woman—a difference of 113 grammes. Prof. Bischoff has found that this difference rises to 134 grammes. The brain of the man is to that of the woman as 109·34 to 100 (Parchappe), as 111 to 100 (Broca, Rudolf, Wagner), as 112 to 100 (Huschke), as 100 to 90 (Meynart).

And it must not be thought that this difference in the weight of the brain is connected with the small size of the woman as compared with the man. According to Parchappe, the size of the woman being to that of the man as 927 to 1,000, the weight of her brain is to that of the brain of the man as 909 to 1,000. "At equal size," says M. Le Bon, "the brain of the woman is much lighter than that of the man. Taking the average weights of seventeen brains of male subjects from 154 to 163 centimeters in height, and comparing them with seventeen brains of women of the same size, I have established between these two averages a difference of 172 grammes in favor of the male brains. The diagrams of female brains of various races show that even in the most intelligent communities, as the Parisians of to-day, there is a notable proportion of the female population whose skulls approach more nearly the volume of those of certain gorillas than of the most highly developed skulls of the male sex."

But there are other differences between the male and female brain, from the conformation. According to all anthropologists (Broca, Wagner, Huschke), the frontal lobes, the seat of the highest intellectual faculties, are less developed in the woman than in the man. Huschke has found 54 cubic centimeters difference in favor of the man for the frontal part. According to Wight, of New York, "the brain of the cultivated or uncultivated man has a relatively larger volume in the anterior portion of the cranium than the brain of the cultivated or uncultivated woman." On the other hand the occipital lobes, which preside over the sentiments, are more voluminous in the woman than in the man. According to Prof. R. Wagner, as a whole, the brain of the woman is always in a more or less embryonic state. Huschke says likewise that the woman is only a child in growth and does not belie her infantile type more in her brain than in the other parts of her body.

Certain anatomists hold that the right brain is superior in the woman and the left in the man. This would explain, according to my idea, why woman, as I have shown, take the left in passing, while men almost always take the right.

In the same way with reference to the faculty of motion, I have found that certain movements, the act of lacing, the act of buttoning, etc., are centrifugal with the man and centripetal with the women, which indicates a sign of inferiority for the latter.*

From a psychological point of view, the anatomical differences which we have described, relative to the prominence of the frontal lobes in the man and of the occipital lobes in the woman, explain to us the opinion according to which the latter should be specially devoted to the life of the sensibilities, and the former to the life of the mind. All authors who have treated of the comparative psychology of the two sexes agree on this point, that the intellectual faculties are superior in the man, and the sentimental in the woman.

Is the woman more moral than the man? Volumes exist of the good and evil which has been spoken of women. Numerous authors have pretended that woman is more greedy, more lazy, more luxurious, more avaricious, more proud, more envious, more malignant, more malicious than man. In the Middle Ages, we find that a council put this question: "Has woman a soul?" The fathers of the church, who pushed slander against the feebler sex to an extreme, may be accused of having allowed themselves to be influenced by the story of the original sin. The same suspicion cannot touch the pagan writers, who hold, for the most part, that woman is a being less perfect than man. Such was the teaching of Hippocrates and Aristotle. Space fails us to refer to the contradictory opinions set forth on this matter by philosophers worthy of being cited. We shall, therefore, try to solve the question by invoking new facts, some of which are furnished to us by demography.

It is incontestable that woman commits less crimes against the person than man. According to Quetelet, she is more easily restrained by sentiments of shame and modesty, by her dependent state, by her more retired habits, and by her physical weakness. "Poisoning, which is the weapon of cowards" says M. Lacassagne, "is more often used by them, as is proved by my statistics, which show that since 1850 the number of women accused of this crime is always larger, and by a large amount, than the number of accused men."

Every one admits, on the other hand, that the woman is more devoted and more charitable than the man. Of the sixty rewards, adjudged in 1880 by the commission of the prix Montyon, forty-seven were merited by women. Yet it is proper to say that woman's charity is often narrow and intolerant, and seems sometimes to have proselytism for a motive.

Let us come to the intellectual faculties and see whether these faculties are more or less developed in the male than in the female. In all the higher species the male is more intelligent than the female. The trainers of educated dogs turn their attention by preference to males.

As regards the human species, all known systems of legislation admit the intellectual inferiority of the female sex in comparison to the male. Everywhere the woman is considered as a minor, incapable of managing herself, and needing a guide and protector. It is principally the lightness and frivolity of the female sex which has determined legislators to place her under guardianship. So it is that the Roman law continually invokes *fragilitatem sexus* in support of the laws which give the woman an inferior position.

To this the partisans of the equality of the two sexes answer that the laws sacrifice the woman to the man because they were framed by the latter.

Moralists have also noted that woman is more playful, more changeable, and more capricious than man. She is also more heedless and less circumspect. The number of broken down women on the public thoroughfare surpasses by far the number of broken down men.

All philosophers and moralists admit that woman is more superstitious, more headstrong, more imitative, and acts more by routine than man. In the estimation of all, she is also more talkative and more timid than man, as the slut barks more and is more timid than the dog.

Some scientific men also hold that woman is less intelligent than man. "The woman," says Broca, "is a little less intelligent than the man." According to Darwin, the man, in all that he undertakes, goes farther than the woman; "that he is moved by deep reflection, by reason, or by imagination, or simply by the usage of the senses or even of the hands;" if a list were prepared of the men, and another of the women most distinguished in poetry, painting, sculpture, science, and philosophy, each containing only a dozen names, these two lists could support no comparison.

It is objected to this that the intellectual inferiority of woman is due to the fact that for some centuries she has not received the same education as man. We shall see further on what is the value of this objection.

Meanwhile we ought to cite the opinion of manufacturers and business men who, employing individuals of both sexes, have been able to compare their faculties. All those whom we have been able to consult think that the woman is more assiduous but less intelligent than the man. In printing-houses, for example, the women work minutely, mechanically, without well knowing what they are doing. It is for this reason that they do well in composing a reprint, a work which requires no intelligence, and badly with manuscripts, which they do not understand as well as men.

Let us, again, record the opinion of insurance brokers, who declare that the woman, always more economical than the man, is the great obstacle to insurances, of which she does not understand the mathematical combinations.

From the standpoint of the evolution of tastes and ideas the woman seems to follow the man at a distance of about a century. One would say that she is about ready to traverse the stages through which we have passed—arts, letters, sciences, philosophy. The artistic and literary paths which the man is tending to abandon for scientific pursuits are now being overrun by the female sex. In 1879 there were 1,717 literary women and 2,150 female artists. According to librarians and directors of reading-rooms, while the man occupies himself altogether with history, philosophy, and science, the woman is still engaged with the story and the romance. Yet, to be just, we must add that Europe and America have some female doctors, and that the day will perhaps come when scientific careers will be disputed with us by women. As to the fact that they have not yet invented anything, we are not authorized to conclude that they are or that they always will be incapable of devising original methods. The future alone can tell us whether woman is only an imitator, or whether she can become a creator by the same title as man.

Summing up, there results from this parallel between the two sexes that, in the higher species, the male is superior to the female not only in the degree of the nutritive phenomena, but also in muscular force and in the development of the intelligence. Besides, there is a connection between nutrition and relation, and it is just because the man, more nourished than the woman, produces more force than she, that he is also more powerful than she physically and intellectually speaking.

Let us add that more biological differences are found between the males than between the females of the same race. If we take, for example, ten Crèvecœur cocks, we shall see that, as regards size and the development of the motive apparatus, they differ much more from each other than ten hens of the same variety. So in the human species, if we consider size, color of the hair, muscular force, voice, tastes, ideas, and even handwriting, we find in women a great resemblance and in men an immense diversity.

Races.—We have seen that the man is superior to the woman in European races; but it is not the same in certain inferior races of the present time, in which the female is more vigorous and more intelligent than the male. The women are less feeble and less stupid than the men in Mathiambu (Bastian, "Voyage en Afrique," 1859), and among the Ashantees, on the west coast of Africa. In Dahomey, they are as warlike as the men. The political organization assigns them a rank officially higher than that of the man. Among the Bodos and Dhimals of the mountains of India and the ancient Pueblos of North America the occupations belong, without distinction, to both sexes, which have nearly the same legal status. According to Meiners, in all Kamchatka the women exercise a sort of supremacy over the men. The men are subordinated to the women in certain tribes of the Afghans, in the island of Java, among the Morotokos, in South America. Among the Balondas, the woman is chief of the tribe. In Cuva, where the women join with the men in battle, their condition is higher than it is among any people. Among the Patagonians, according to De Rochas, the women are almost as large and altogether as strong as the men. A woman is the chief. "In many of the tribes of blacks, the woman is the head of the family, and she even beats the man" (Folley).

When, in the lower races, the man excels the woman, his superiority is always less than in the higher races.

Let us consider, for example, the length of the radius, the humerus being 100. According to Broca, this length would be about 79·43 in the negro, 79·35 in the negress, a difference of eight-hundredths; about 73·82 in the male European and 74·02 in the female, a difference of twenty-hundredths. The male European, says Broca, rises more above the female than the negro above the negress.

Let us take the dimensions of the scapula. According to Dr. Livon (Paris, 1879), the division between the two sexes is greater in the higher races than in the lower, and this separation goes on diminishing in proportion as we descend from the higher to the lower types.

Let us consider the size. The difference in size between the man and the woman is much less in the lower races than in the higher. The two sexes are of the same size among the Bochismans and even among the Patagonians (De Rochas). In Europeans the difference in size in favor of the man is, on the average, about 96 millimeters, according to Quetelet, and about 12 centimeters, according to M. Topinard.

Let us proceed to the cranial capacity. The difference in favor of the man, which is about 37 cubic centimeters in the Australian (Davis), rises to 59 in the Chinese, according to the same author, to 129 in the neo-Caledonian (Broca), to 149 in the Esquimau, to 203 in the Englishman, and to 221 among the Parisians (Broca). M. Huschke also has found that the difference in cranial capacity in favor of the man is by so much the greater as the races are higher. J. B. Davis has arrived at the same result concerning the cerebral superiority of the man.

In conclusion, let us consider the exterior appearance. According to M. G. Pouchet, among the Arabs of Upper Nubia the women greatly resemble the men. So, according to M. Pruner Bey, "the Druse women differ very little from the men, which is the case in uncivilized peoples, and in the lower classes of civilized people, which has caused this law to be formulated, that the outer form in the two sexes differs by so much the less as the races are less civilized."

Without going so far, according to certain anthropologists, there should be less difference between the Russian man and woman than between the French man and woman.

What we have observed in the lower tribes of the present time, was likewise observed in the inferior races of ancient times. Not to speak of the empire of the Amazons, in which, according to the legend, the women held the men in slavery, certain peoples of antiquity have been governed by women—Semiramis, Dido, Athalia, Cleopatra, Zenobia, etc. Diodorus noted the equality of the two sexes among the ancient Scythians. According to the Roman historians, the women fought with as much courage as the men among the Teutons, the Cimbri, and the Gauls. In certain Pelasgian populations and among the Ibero-Ligurians, the women decided concerning peace and war. On the other hand, among the Romans and Greeks, the physical and intellectual pre eminence of the man over the woman was considerable.

This pre-eminence, which we always meet in the higher races, increases in the same ratio as the progress of evolution. According to the researches of Broca, the difference of cranial capacity in favor of the man, which was about 100 cubic centimeters in the race of Cro-Magnon, is about 150 in the French as a whole, and 221 in the Parisian. Curiously, the cranial capacity was greater in the pre-historic woman than in the woman of the present day. "It seems proved," says Broca, "that the women, participating in the labors of the men more actively, had at the same time a more considerable cerebral capacity than in our days."

"The difference existing between the weight of the brain of the man and that of the woman goes on increasing constantly as we rise in the scale of civilization, so that, in regard to the mass of the brain and in intelligence, the woman tends to become more and more different from the man. The difference which exists, for example, between the averages of the crania of contemporary male and female Parisians is almost double that observed between the male and female crania of ancient Egypt (Le Bon). In the same way Zanetti, in Sardinia, has arrived at this conclusion relative to the cranial capacity, that modern women differ more from modern men than ancient women from ancient men.

Summing up, the superiority of the woman is sometimes met with in the lower races, ancient or present, but it is never observed in the higher races, which, on the contrary, are always characterized by the pre-eminence of the man. So, whether we consider species or races, we always see the evolution proceeding from the superiority of the female to that of the male.

Age.—In the same manner, in regard to age, the evolution seems to go from the transient pre-eminence of the female sex to the lasting superiority of the male. Bowdicht, of Boston, and Pagliani, have noted the superiority in size of girls from 10 to 15. According to certain anthropologists, from 10 to 12 years old the girl should gain one pound per year more than the boy. But this superiority has only one season; after 17, the man continues to grow, and the woman remains stationary.

It is the same of the intellect. In mixed schools, the instructors observe that the girls are the first in their studies up to 12 years, and the last afterward. The woman is then physically, morally, and intellectually, more precocious than the man. This is what has caused it to be believed that she was more intelligent. Buffon explains the slow completion of the man's growth as follows: "Since men are much larger and stronger than women, since they have a more solid and more massive body, harder bones, firmer muscles, more compact flesh, we must presume that the time necessary for the growth of their body should be longer than the time necessary for the growth of that of women." "The woman," says Cabanis, "grows more rapidly and wastes in the same manner. She passes from a premature adolescence to an old age still more premature. There is for her no interval between the childhood of the first age and that of the last."

But this precocity itself, according to the researches which

* See the *Revue Scientifique* for Dec. 28, 1880.

I have presented before the Society of Biology, and which I cannot enter into here, is a sign of inferiority which is observed in all females. We know that in all the domestic species the females are formed earlier than the males. This precocity, which is observed equally in animals and in men of inferior races, is a sign of inferiority, because it is always followed by an arrest of development.

In a general way the man differs more from the woman at an adult age than during youth or old age, so that the maximum of superiority of the masculine sex over the feminine corresponds to the apogee of evolution. Whether we consider the organism in general or the various organs in particular, we see that the differences, nothing during the fœtal life and feeble at birth, increase until the adult age, where they attain their highest point, then diminish in the course of old age.

Let us take size for example. According to Quetelet, "at equal age the woman differs the least from the man during the first years of life. At the moment of birth the boys have one centimeter more than the girls." At adult age, the difference in size in favor of the man should be, according to Quetelet, about 86 millimeters, and according to M. Topinard, about 12 centimeters. Later, the equality of size tends to be re-established between the two sexes, because the man loses more of his size than the woman.

If we take the weight we arrive at the same conclusions. In France the average weight of a new-born child is about 3,250 grammes for boys and about 2,900 grammes for girls, a difference of 350 grammes in favor of the masculine sex. This difference increases but slightly during the first twelve years and considerably afterward, until, according to Quetelet, it reaches 4·5 kilogrammes at adult age. According to certain anthropologists, it is from 1 kg. to 1·5 kg. from 1 to 11 years, about 6 kg. from 16 to 20 years, and on the average about 8 kg. after this period. Later, it diminishes in the course of old age, as the researches of Guy prove. According to this anthropologist, the difference in favor of the man is about 1 kg. from 2 to 7 years, rises to 6 kg. from 14 to 21 years, to 7 from 21 to 28, to 11 from 41 to 56, then decreases to 9 from 56 to 63, and to 8 from 63 to 70.

Let us take the volume of the head and the mass of the brain. We know that at birth boys have one centimeter more in circumference of head than girls (Liharzic). This difference increases at mature age because the head ceases to expand at an early period in the woman and continues to grow in the man.

In regard to the weight of the brain, according to the weights of Welcker, the difference in favor of the masculine sex is 40 grammes at birth, 50 at 1 year, 70 at 3 years, 110 at 10 years, 150 from 20 to 60 years, and diminishes after 60 years. Broca likewise has found a difference of 92 grammes from 21 to 30 years, 148 grammes from 31 to 40, 130 grammes from 41 to 50, 105 grammes from 51 to 60. So the difference in favor of the man, which is 7 per cent. from 21 to 30 years, rises to 11 per cent. from 31 to 40, then falls to 10 per cent. from 40 to 50, and to 8 per cent. from 50 to 60. Beyond 60 years the weight of the brain begins to diminish in such a manner that in old age it has lost, in the man, 84 grammes, and in the woman 59 grammes of the average weight which it reached in mature age. These anatomical differences involve the intellectual and moral differences which explain why, in the higher societies, the two sexes, after having played the same games in childhood, separate intellectually during mature age and again approach each other during old age.

In regard to the general appearance, there are the same proofs. "In childhood and up to puberty," says M. Topinard, "the frame does not differ in an appreciable degree; the traits are rather feminine. At puberty the man begins to be formed. . . . At about 45 years or over, the distinctions commence to grow small, and in advanced old age the two sexes end by resembling each other; but then the characteristics are rather masculine."

We can study in the same way the nutritive phenomena. We know that the man produces more carbonic acid than the woman—the difference is 1·4 gr. at eight years, and nearly 5 gr. from sixteen to thirty years (Andral and Gavaret). The pulmonary capacity diminishes year by year after thirty years, but in a higher proportion in the man than in the woman.

So also if we consider the lungs, which are in the man more extensive than in the woman, we see that the difference in weight in favor of the man increases up to adult age and thence diminishes in the course of old age. Indeed, this difference, which is 97 grammes from sixty-five to eighty-five years, is not more than 66 grammes from eighty-five to ninety years.

Let us consider the quantity of salts contained in the blood. According to Quetelet, the difference in favor of the man is 0·99 at one year, 3·7 at ten years, and 20·05 at thirty years. Let us consider the hemiglobin; from ten years old the blood of the woman is always poorer in hemiglobin (Lichtenstein).

Let us take the pulse. We know that it is 132 in the male fœtus and 138 in the female (Devilliers). According to Guy, the man has one beat per minute less than the woman from two to seven years, six from fourteen to twenty-one years, seven from twenty-one to twenty-eight years, ten from thirty-five to forty-two, eleven at fifty years, then nine from fifty-six to sixty-three, and eight from sixty-three to seventy.

On the whole, the woman excels the man in certain respects during the first twelve years. Then the man in his turn excels the woman, and his superiority increases up to mature age, to decrease during old age. This pre-eminence is, then, in direct ratio to the evolution, since its maximum corresponds to the apogee of evolution, which, as we know, occurs between forty and fifty years.

Constitution.—The superiority of man over woman is greater in large persons than in small. M. Verneau, speaking of the dimensions of the pelvis, says: "The differences between the sexes are proportionally greater in a general way as the size is greater, and less as the size is smaller."

This pre-eminence is greater in inhabitants of cities than in those of the country, and in Parisians than in provincials. According to Broca, the French man in general has 150 cubic centimeters of cranial capacity more than the French woman, while the male Parisian has 221 more than the female. M. Pruner Bey, after having said that in uncivilized races the women have masculine forms which make them resemble the men, adds that this phenomenon exists also, though in a smaller degree, in the "lower classes" of civilized races. In our cities it is easy to observe that the man differs much more from the woman in the rich classes than in the poor. In these latter classes it often happens that the woman is more intelligent than the man, often brutalized by manual labor and sometimes also by drink. The lawyers of the Paris bar, who have to plead for laborers, have remarked that the women of the working class are better able to explain their business than their husbands; so they say to the latter, "Send me your wife."

The biological considerations which precede explain why the two sexes tend to separate from each other, in proportion as we rise from the lower to the higher classes. Among peasants and laborers the two sexes, having almost the same intellectual and moral faculties, can sympathize with each other and have no cause to grow apart. It is not the same in the intelligent classes of the cities, where the two sexes, by reason of the greater and greater pre eminence of the men, no longer having the same ideas, the same sentiments, or the same tastes, cannot understand each other, and therefore form sets by themselves. For a long time moralists have noted this separation which is wrought between the two sexes in the family, in the reunions of men and of women, and which seems to increase from year to year.

We know by the researches of M. Le Bon that the various classes of society should be ranged in the following manner according to cranial capacity: Men of letters and savants, citizens, nobles, servants, peasants. This separation of which we speak increases in proportion as we rise from the peasant to the savant, passing over the servant, the noble, and the common citizen. It is incontestably less in the Faubourg Saint-Germain, where the two sexes have the same opinions, than in the spheres of science, where the two sexes are widely divided. It seems, then, like the pre-eminence of man over woman, to be in the ratio of the cranial capacity and development of intelligence.

Manipulation.—One might believe that the physical and intellectual inferiority of the woman depended on the fact that her muscles and her brain are less exercised than those of the male. This is not the case.

In regard to strength, in circuses, where children of both sexes receive the same physical education, it is easy to see that the boy is always more vigorous than the girl and constantly preserves his superiority over her. Certain difficult feats which the men accomplish readily are interdicted to the women. So also trained dogs are almost always males.

The partisans of the equality of the two sexes think that it is not the same from an intellectual point of view, and that the pretended superiority of the man in the same matter comes from the fact that the two sexes have not received the same education, and are not found in the same intellectual condition. "Woman," says Buchner, "has for thousands of years received and continues to receive an education much inferior to that of man." This objection is not just. In past ages, when the mass of the people were in ignorance, neither sex received more instruction than the other, and in our day, in modern France, have we not still 600,000 children who never put foot in school and are absolutely without education? We can then say, with Professor Bischoff of Munich, "Women have no other hinderances to the exercise and evolution of their brain and their intelligence than those which proceed from their constitution and faculties of development."

It is also false to pretend that woman never receives the same education as man. Do not female musicians, for example, receive exactly the same instruction as males in schools, in seminaries, in the conservatories, etc.? Therefore, how does it happen, although there are incomparably more female than male musicians, that women furnish the best executionists but no composers?

What we have just said of music is applicable to painting and even to the art of cookery. How does it happen that all the men who devote themselves to this latter art are good cooks, while, among the thousands of women who exercise the profession of cook, there are so few *cordons bleus?*

So also, in mixed schools, where both sexes receive exactly the same education up to fifteen years, we have seen that the girls, after having originally been the first, by virtue of their natural precocity, after the age of twelve can no longer follow the boys. This arrest of development, undergone by the woman, is the true cause of the greater and greater pre-eminence of the man, who, for his part, continues to develop up to an advanced age. The woman is, then, at first more intelligent than the man, and it would only depend on herself to preserve her original superiority. If at twelve years, when she is receiving the same education as the man, she becomes inferior to the latter, it is because her inferiority is really natural and does not spring from a difference of education, which in this case does not exist.

Thus the instruction given equally to both sexes is not able to restore the equality between them. On the contrary, the equal working of the brain increases the superiority of the man over the woman, which shows, by this consideration, that the latter is inferior to the former. The equality of the two sexes dreamed of by philosophers is, then, not near its accomplishment. On the contrary, this equality, which existed in the primitive races and which still exists to-day among certain savages, tends to disappear more and more with the progress of civilization. The pre-eminence of the man over the woman, which is a product of the evolution of individuals and races, has been further increased by instruction, which, so far from re-establishing the equality between the two sexes, assures definitely the supremacy of the man.

Position.—It would be interesting to trace the action exercised by position on the differences existing between the two sexes. I am urged to believe that these differences diminish in proportion as we descend to the South. Thus, in Italy, according to statistics published by the Minister of Agriculture, and covering a period of fourteen years, the excess in height in favor of the man is 42 millimeters in the northern region and only 29 in the southern. The same is true, according to Broca, who finds that in mountainous countries the height of the woman approaches nearer to that of the man than in lower districts.

Conclusion.—Summing up, the superiority of the feminine sex over the masculine, encountered only in certain lower races and species and in the children of the higher races, indicates a lower degree of evolution.

It is the same with the equality of the two sexes, which is observed only in individuals slightly advanced in the scale of evolution; lower species and races, youths, old people, and lower classes.

On the other hand the superiority of the male over the female represents a higher phase of evolution, since it characterizes the higher species and races, the mature age and the higher classes.

From the moral as well as from a physical standpoint evolution seems to me to advance from the pre-eminence of the feminine sex to that of the masculine, and the equality of the two sexes would be the natural transition between these two opposed phases of evolution.—*Revue Scientifique.*

ORIGIN OF YELLOW FEVER.—Dr. Manuel Da Gama Lobo has found at Vera Cruz, Mexico, and Havana, Cuba, sufficient evidence to warrant him in stating that these localities are fruitful sources of a poison which causes yellow fever. The toxic agent is derived from a species of infusoria, the *Opunsia mexicana*, which belongs to the family of *bacilla.*—*Sanitary News.*

HOT ICE.

DR. A. WÜLLNER has repeated, by means of a modified form of apparatus, some of the experiments described by Mr. Carnelley. [See SCIENTIFIC AMERICAN SUPPLEMENT, No. 271, for Dr. Carnelley's original note to the Royal Society.] He finds that *so long as the bulb of the thermometer is completely surrounded by dry ice, its temperature does not reach* 0° C. If the thermometer rises higher, either the bulb is no longer quite covered with ice, or it is surrounded by water together with a thicker layer of ice. In other respects the course of the experiment was exactly as described by Mr. Carnelley. When the bulb becomes partially bare of ice, the thermometer will rise even to 50° before the ice becomes detached, and rapid heating would probably cause it to rise considerably higher. The detached ice, when it comes in contact with the hot glass, dances about like Leidenfrost's drops.

In order that fusion may not take place, the ice must not be too thick, but how thick was not determined. In one experiment the bulb was surrounded by a coating of ice from 1 to 1·5 centimeters thick, and strongly heated by the flame of a Bunsen's burner; the temperature rose quickly to 0°, when fusion commenced, *not on the surface, but in the center of the ice, and in such a way that the water was forced out through the surface in small drops, like blisters*, and these, on the removal of the lamp, instantly froze. By heating again and again, the same phenomenon was repeated several times.

In a quantitative experiment, 75 grammes of ice were kept under low pressure and exposed to the temperature of steam from boiling water for five hours; no fusion occurred, and 42 grammes of ice were volatilized into the condenser.—*Ann. Chim. Phys.*

A CATALOGUE, containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

COMBINED RATES —One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
37 Park Row, New York, N. Y.

TABLE OF CONTENTS.